Intermediate (60%) Groundwater Basis of Design/Design Criteria Report

Volume I

Interim Groundwater Remedy Remedial Design

Standard Chlorine of Delaware Site
New Castle County, Delaware

USEPA Work Assignment No. 038-RDRD-03H6
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1.0 Introduction

The United States Environmental Protection Agency (EPA), under the authority of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), has initiated procedures to conduct a Remedial Design (RD) at the Standard Chlorine of Delaware (SCD) Site, New Castle County, DE. This Intermediate (60%) Design Criteria/Basis of Design Report has been prepared by the Tetra Tech/Black & Veatch Joint Venture (JV) under Contract Number 68-S7-3002 with EPA Region III and under specific authorization of EPA Region III through Work Assignment Number 038-RDRD-03H6. Black & Veatch Special Projects Corp. (BVSPC) is the lead member of the JV for this work assignment.

1.1 Purpose and Scope

In accordance with the Remedial Design Work Plan, BVSPC presents this Intermediate (60%) Design Criteria/Basis of Design Report (Report) for the Interim Groundwater Remedy of the SCD Site in New Castle County, DE. This Report represents an approximately 60 percent level of completion for the groundwater extraction, product recovery, and groundwater treatment systems to be employed at the SCD Site. Because of additional data and modeling requirements necessary to advance the barrier wall portion of the design – and in accordance with previous discussions with EPA – the report detailing the intermediate barrier wall design will be submitted as a separate addendum. Included in this Report are descriptions and objectives of the proposed groundwater remedy, design criteria and basis, a project delivery strategy, revised drawings and draft specifications, and a revised schedule and cost estimate. Not included as part of this submission are design details for the proposed extraction/treatment systems that represent efforts beyond the 60 percent level of completion. In addition, no details of the proposed barrier wall design or related groundwater model beyond those presented in the previously submitted Preliminary Design Criteria/Basis of Design Report are included in this document. In accordance with EPA Superfund Remedial Design and Remedial Action Guidance, the Prefinal design submission will build upon this submission, providing greater detail and information required for successful implementation of the remedial action.

1.2 Report Organization

This Report is organized into the following sections:

$ Section 1 contains the Introduction to this document.
$ Section 2 contains a brief description of the SCD Site, including physical setting, geology, hydrogeology, and groundwater characterization.
$ Section 3 presents a description of the proposed groundwater remedy and each of its primary components.
$ Section 4 presents the Design Criteria, including relevant design issues.
$ Section 5 describes the Preliminary Basis of Design.
$ Section 6 contains BVSPC's proposed Project Delivery Strategy.
$ Section 7 contains an overview of the Preliminary Design Drawings.
$ Section 8 consists of an outline of the proposed Project Specifications.
$ Section 9 provides the estimated Remedial Action Schedule.
$ Section 10 provides a Preliminary Remedial Action Cost Estimate.

2.0 Site Conditions

2.1 Site Location and Description

The SCD Site is located on Governor Lea Road, in an industrialized area located approximately three miles northwest of Delaware City in New Castle County, Delaware. Residential and commercial properties are located within one mile of the facility (to the west). The SCD Site is bordered to the east by Occidental Chemical Company (formerly Diamond Shamrock Company) property, to the west by Air Products, Inc. and to the south by Governor Lea Road. Governor Lea Road separates the SCD Site from property owned by Motiva Enterprises, LLC (formerly Star Enterprises) and Connectiv (formerly Delmarva Power and Light). The fence line of the former SCD/Metachem manufacturing facility (facility) encompasses approximately 25 acres. The SCD Site as a whole encompasses approximately 65 acres with its southernmost boundary adjacent to Governor Lea Road and its northern extent reaching to edge of Red Lion Creek. The site location is presented in Figure 2-1.

The SCD facility's wastewater treatment plant (WWTP) was used to treat process wastewater and process area stormwater runoff and includes an open catch basin (located near the center of the facility). The land between the SCD facility and the Red Lion Creek is wooded (trees typically less than 6 inches diameter). This area remains undeveloped with the exception of gravel roads (single lane), a sedimentation basin, two soil piles, and other features constructed as part of past remedial and monitoring activities. Near the Red Lion Creek and its unnamed tributary (located to the west of Air Products and the undeveloped area to the north of the facility), the terrain slopes sharply downward into wetlands areas surrounding these two water bodies.

2.2 Site History

The SCD facility was built in 1965 on approximately 46 acres of farmland that was previously owned by the Diamond Alkali Company. The Diamond Alkali Company had previously purchased the land from the Tidewater Refinery Company. Chlorinated benzene compounds were manufactured onsite from 1966 until the facility's closure in May 2002. Chlorine (piped in from the Occidental Chemical facility) and benzene (obtained primarily from the Motiva facility located on the south side of Governor Lea Road) were the main raw materials for chlorinated benzene production processes. The facility underwent an expansion in the early 1970s to begin production of chlorinated nitrobenzene and to increase production of chlorobenzene, dichlorobenzene, and trichlorobenzene. Production of chlorinated nitrobenzene ended in the late 1970s, and the related capacity was switched to the production of chlorobenzene. The facility was also expanded in the late 1970s. Following that expansion, the SCD facility produced chlorobenzene, paradichlorobenzene, various isomers of trichlorobenzene, and chlorobenzene-based insulating fluids (Weston, 1993).

In December of 1998, SCD was sold as a whole to Metachem Products, LLC (Metachem). According to Metachem's former Environmental Manager, Metachem also purchased all of the land located between the facility boundaries and the Red Lion Creek that was known to have been impacted by SCD's releases. SCD (and its successor company, Metachem) have been identified as PRPs.

2.2.1 1981 Release and Response

In September of 1981, approximately 5,000 gallons of chlorobenzene were released during the transfer of chemicals to a railroad tank car. This release occurred near the western boundary of the SCD Site. Spilled chemicals traveled along the western boundary of the SCD Site and into the drainage ditch that runs westward along Governor Lea Road towards an unnamed tributary of the Red Lion Creek. As part of their response action, SCD recovered a portion of the surface runoff and removed surface soils in the release area and the drainage ditch located along Governor Lea Road. The excavated soil was then shipped to a permitted off-site disposal facility. This removal action was performed under the supervision of the Delaware Department of Natural Resources and Environmental Control (DNREC). As stated in the 1992 Remedial Investigation (RI) Report, SCD also conducted a limited subsurface investigation in the area of the release to determine the potential for migration of the spilled chlorobenzene into the underlying groundwater. Based on the results of this investigation, SCD and DNREC concluded that the potential existed for groundwater contamination to occur (Weston, 1992).

Following these actions, SCD, through its contractor, conducted additional investigation and assessment activities that included the installation of groundwater monitoring wells at various locations on the SCD property. The sampling and analysis conducted as part of these investigations revealed that the groundwater was contaminated with multiple types of chlorinated benzenes. It was subsequently determined that the primary source for the chlorinated benzenes in the groundwater was a leak that SCD detected in the WWTP's Catch Basin Number 1 in March 1976. According to the 1992 Feasibility

Study (FS) performed by SCD's contractor, this catch basin was repaired by SCD in 1976, but the surrounding soils – in which contamination has been detected – were left in place (Weston, 1993).

To address the groundwater contamination, SCD installed a series of recovery wells and modified their existing WWTP to include an air stripper. An additional clarifier and tertiary sand filter were added to address the increased flow. A modified NPDES permit for the facility was issued by DNREC on January 21, 1985 and the modified system was brought on-line in 1986. At some point following their installation, the recovery wells associated with this modified system fell into disrepair, and none of the wells are currently functioning.

2.2.2 1986 Release and Response

A subsequent incident that occurred in January 1986 involved the failure of a 375,000-gallon tank located near the western boundary of the SCD Site. The spill resulting from the collapse of this first tank damaged three nearby tanks causing additional volumes of volatile organic compounds (VOCs) to be released. A total of approximately 569,000 gallons of various VOCs – including chlorobenzene, paradichlorobenzene and trichlorobenzene compounds – were released during this incident.

A portion of the spilled chemicals from this release solidified on contact with the paved areas of the SCD facility. Much of this material was subsequently recovered for reprocessing by SCD.

Some of the spilled chemicals from the 1986 release traveled northward to the northwest corner of the SCD property. From this point, they flowed down the western drainage gully and into a wetlands area surrounding an unnamed tributary of the Red Lion Creek located to the west of the facility. Another portion of the chemicals from the 1986 release flowed eastward across paved sections of the SCD property into the eastern drainage ditch. This material then traveled northward until it reached the facility's northern fence line. Investigations to further delineate the spill pathway are currently planned for Winter 2003/Spring 2004.

As part of the initial response to this spill, SCD constructed a berm and a silt fence across the aforementioned tributary wetlands area. These were constructed to minimize the transport of contaminants into the Red Lion Creek. Contaminated sediments were excavated from the wetlands area to the north of the silt fence and placed in a lined sedimentation basin that was constructed to the north of the SCD facility fence line. Other contaminated materials were placed in soil piles that were constructed to the northwest of the facility fence line (Weston, 1992).

During the RI, water samples collected from between the two layers of the sedimentation basin's liner showed the presence of site contaminants. This, together with the age of the liner system, suggests that the contamination might have migrated from the basin into the underlying soil and groundwater. During the field activities conducted as part of this RD, it was determined that the silt fence that was installed in the tributary wetlands area had deteriorated to the point that it was no longer functional.

2.2.3 Catch Basin Number 1 Release

In March 1976, SCD determined that Catch Basin Number 1 – a settling basin in the facility's WWTP – had been leaking. The RI Report states that this basin was excavated at that time and replaced along with a portion of the surrounding underground piping. The RI Report also states that most subsurface chlorinated benzene contamination that is not attributable to the 1981 and 1986 releases is thought to have come from Catch Basin Number 1 (Weston, 1992). Although the RI Report mentions that integrity testing was being performed annually as of 1992, there is no indication of how long the basin had been leaking prior to its replacement.

2.3 Site Status

Because of the releases described above, the SCD Site was added to the National Priorities List (NPL) in 1987. A Consent Order (between DNREC and SCD) covering the performance of a Remedial Investigation and Feasibility Study (RI/FS) at the SCD Site was signed on January 12, 1988 and amended on November 14, 1988. The Record of Decision (ROD) for the site was completed on March 9, 1995, and an Administrative Order for Remedial Design and Remedial Action was signed on May 30, 1996.

Primary contaminants of concern (COCs) identified in the ROD include:

• Benzene	• Pentachlorobenzene
• Chlorobenzene	• 1,2,3,4-Tetrachlorobenzene
• 1,2-Dichlorobenzene	• 1,2,4,5-Tetrachlorobenzene
• 1,3-Dichlorobenzene	• Toluene
• 1,4-Dichlorobenzene	• 1,2,3-Trichlorobenzene

• Hexachlorobenzene	• 1,2,4-Trichlorobenzene
• Nitrobenzene	• 1,3,5-Trichlorobenzene

The Baseline Risk Assessment (BLRA) and subsequent RD activities have also identified polychlorinated biphenyls (PCBs), metachloronitrobenzene, and dioxins as site-related contaminants (ROD, 1995).

On April 30, 2002, following the bankruptcy of one of their major customers, Metachem announced that they would close the SCD facility. At that time, Metachem did not specify a closing date, and they left open the possibility of having the plant operate at a reduced capacity. Metachem closed the facility on May 4, 2002 and declared bankruptcy six days later (May 10, 2002). Shortly after this, Metachem abandoned the SCD Site (on May 14, 2002) to the EPA and DNREC. Since then, the USEPA and DNREC have been cooperating to implement an emergency cleanup action and determine an approach for the long-term rehabilitation of the SCD Site.

While the SCD facility is no longer an active manufacturing plant, chemical removal/site decontamination activities, involving EPA and DNREC, are currently in progress. As part of these activities, a portion of the SCD facility=s equipment, including the WWTP and various process equipment are currently being operated by the EPA, DNREC, and their respective contractors. It is anticipated that the WWTP will be deactivated (along with the facility boilers) within the first quarter of 2004. The rail siding located on the western side of the facility is being utilized during chemical removal efforts, but its use will also decrease as the process of removing liquid phase chemicals from the facility winds down.

2.4 Hydrogeologic Setting

Due to extensive investigations performed at the site, the RD work assignment (WA) for the SCD did not require BVSPC to perform a detailed investigation of the hydrogeologic conditions at the site. Therefore, the following sections are a compilation of investigations that were performed at the SCD Site by various PRP contractors. Additional geologic and water quality data was collected by BVSPC during the remedial design investigation to fill various data gaps for the RD. This data will supplement previous work performed at the site. In addition, a new groundwater model was generated by BVSPC for the preliminary groundwater RD. Portions of the BVSPC groundwater model report are summarized or included below. The entire groundwater model report is included as Appendix A. An updated version of this model that takes into account the impact of data to be gathered during upcoming geotechnical investigations will be submitted with the Intermediate (60%) Basis of Design/Design Criteria Containment Barrier Addendum.

The SCD Site is located in the Atlantic Coastal Plain Physiographic Province at approximately 12 miles from the Fall Line, which divides the Piedmont Province and the Coastal Plain. The Atlantic Coastal Plain in New Jersey and Delaware is underlain by a wedge-shaped mass of unconsolidated to semi-consolidated deposits that rest on crystalline bedrock and thicken toward the Atlantic Ocean.

The stratigraphy of the Coastal Plain Province includes interbedding of fine- and coarse-grained sediments that consist of silt, clay, and sand, with gravel and lignite. The sediments were deposited in marine environment from late Cretaceous through early Tertiary time. Because of shifting between deltaic and alluvial deposition, sediment types and textures can change greatly within short horizontal distances. Formations present at the site include the Columbia, Merchantville, and Potomac.

The Columbia Formation, the upper-most aquifer at the SCD Site, is a part of a north-south trending channel filled with unconsolidated sand and gravel that includes pockets of silts and clays. Its thickness at the site varies between approximately 25 and 45 feet. The Columbia Formation is underlain by either the Merchantville Formation, which includes dark gray to black, micaceous clay to silty-clay soil, or the top of the Potomac clay. The Columbia aquifer directly overlies the Potomac clays where the Merchantville Formation has been incised. The presence of a continuous clay/silty-clay layer that limits groundwater flow between the Columbia aquifer and the Potomac aquifer at the SCD Site has been suggested by most existing Site data, but boring logs from two borings (SB-41 and TB-41) indicate that this layer might not be continuous. Furthermore, a recent investigation of Potomac Aquifer water quality suggests that some transmission occurs between the two formations.

2.4.1 Topography and Surface Drainage

The SCD facility is situated on a generally flat area of land bounded by Red Lion Creek to the north, an unnamed tributary to Red Lion Creek to the west and topographic highs to the south and east. A wooded area runs between the facility and Red Lion Creek. This area decreases in elevation from about 50 ft above mean sea level (MSL) at the facility to near sea level at Red Lion Creek. This area also exhibits a north-south trending surface water divide that splits the center of the site and wooded area.

The surface drainage is controlled by topographic highs near the SCD Site and Governor Lea Road and flows in a dendritic pattern toward the dominant drainage feature of Red Lion Creek. The surface water divide on the site guides drainage to the Eastern Drainage Ditch – a shallow (approximately two to four ft deep) drainage ditch that runs through the eastern portion of the facility – and a shallower drainage feature that runs along the facility's western boundary. These drainage features capture and direct stormwater to two weirs that are located in the northeastern and northwestern corners of the facility, respectively. These weirs discharge the stormwater offsite under NPDES permits with the western weir discharging to the Red Lion Creek via the unnamed tributary and the Western Drainage Gully, while the eastern feature discharges overland to the Red Lion Creek. In the wooded area, drainage is generally east-west controlled by the divide.

2.4.2 Recharge and Discharge

A water budget was developed by Conestoga-Rovers & Associates (CRA) in September 2001. Based on annual precipitation data collected at the New Castle County airport for the last 30 years, the average rainfall rate in the site vicinity is 43 inches per year (in/yr). A large percentage, 26 inches (59 percent) of the precipitation is lost to evapotranspiration, and about 3 to 6 inches (7 to 14 percent) is lost to direct runoff. Of the remaining rainfall, a relatively high percentage infiltrates as groundwater recharge. The groundwater recharge from precipitation infiltration is on average 12.5 in/yr. The volume of water recharge in the 7,700 acres of the Red Lion Creek drainage basin is estimated to be 2.62 billion gallons per year (CRA 2001).

The majority of the shallow groundwater discharges to Red Lion Creek and the surrounding marsh area. In addition, a potable water supply well (Glen-2) operated by the Artesian Water Supply Company is located within the drainage basin. This well has an average pumping rate of 250 gallons per minute (gpm) or 362,000 gallons per day (gpd). The five former recovery wells at the SCD facility had a capacity at a combined rate of 150 gpm, and Motiva has three recovery wells capable of a combined 120 gpm (CRA 2001).

Based on the groundwater withdrawals from the industrial and public water users, the total pumping well withdrawal is 201 million gallons per year. Using these figures, the water budget calculates that Red Lion Creek discharges approximately 2.42 billion gallons per year. This corresponds to stream flow measurements of about 10 cubic feet per second (ft^3/sec) collected by CRA (CRA 2001).

2.4.3 General Aquifer Characteristics

The Columbia Formation is the uppermost aquifer in the area of the SCD Site. The aquifer is unconfined and underlain by the Merchantville Formation silts and clays. In areas where the Merchantville Formation is missing, the upper Potomac Formation silts and clays underlie the Columbia Aquifer. In some areas of the site these clay and silty clay deposits form an aquitard at the bottom of the Columbia Aquifer, but recent test data from samples collected from the Potomac Aquifer indicate that contamination might have crossed this layer into the Potomac.

Groundwater flow within the Columbia Aquifer mimics the surface topography (flowing northward towards the Red Lion Creek) while the flow in the Potomac Aquifer is primarily to the southeast (towards the Delaware River). On the northern, western and southern portions of the Red Lion Creek Watershed, a groundwater divide is assumed to exist in the Columbia Aquifer at the topographic highs of the watershed boundary.

The Red Lion Creek Watershed is bounded by the Delaware River on the east. Red Lion Creek discharges into the Delaware River approximately 6,000 feet east of the SCD Site. The water level of the Delaware River is tidal with changes in the order of 4.22 feet. Tidal gates installed near the mouth of the Red Lion Creek have minimized the influence of the river’s tidal changes on the creek.

The water table forms the upper boundary of the Columbia Aquifer. The site water level may slightly fluctuate due to seasonal precipitation changes. Groundwater from the SCD Site flows towards Red Lion Creek, its unnamed tributary, and the surrounding marsh area. The average hydraulic gradient of groundwater is 0.003 feet/foot to the north-northeast. The aquifer hydraulic conductivity is estimated to range from 5 to 134 feet per day.

The water level in Red Lion Creek is lower than groundwater table in the Columbia Aquifer. USGS maps of the area indicate wetland areas with bank storage at several locations near the Red Lion Creek. Because groundwater level is higher than the Red Lion Creek water level, groundwater flows towards the creek and its tributaries and then discharges.

2.4.4 Site Specific Aquifer Characteristics

In addition to identifying the general characteristics of the Columbia and Potomac aquifers, it is necessary to understand how the nature of the aquifers in the immediate area of the SCD Site will impact the Interim Groundwater Remedy.

2.4.4.1 Previous Hydrogeologic Investigations

To gain a better picture of the specific nature of the aquifers underlying the SCD Site, several hydrogeologic investigations have been performed at the site including the following:

- Pump Tests

    1. A 72-hour pump test was conducted by Roy F. Weston on May 17, 1982 on TW-6.
    2. A 72-hour pump test was conducted by Roy F. Weston, Inc. in October 1990 on OR6A.
    3. A step drawdown test on April 30, 2001, and a 48-hour aquifer test and recovery from April 30 to May 2, 2001 on MW-40 were conducted by CRA.
    4. A 24-hour aquifer test was conducted by CRA between May 2 and 3, 2001 on MW-25.

- Water Level Measurements

    1. In August 1990, site wide water level measurements were collected.
    2. On May 14, 2001 water levels were collected to provide a complete picture of the groundwater elevations at and in the vicinity of the SCD Site, including north of Red Lion Creek and east (OxyChem) and south (Motiva) of the SCD Site. Groundwater flows from south to north across the site and discharges to the Red Lion Creek.

- Tidal Investigations

    Staff gauges were installed and monitored in Red Lion Creek and the unnamed tributary. When the tidal gates were open, measured tidal variations were 4.22 feet and 2.85 feet in Red Lion Creek and the Delaware River respectively. The tide gates exhibit a strong influence on the Red Lion Creek water level fluctuation. When the tide gates are closed, the tidal change in the Red Lion Creek is minimal. Water level measurement results indicated that there was minimal tidal variation in the water level in the unnamed tributary.

- Stream flow measurements

In Red Lion Creek, stream flow increases from west to east implying that the Red Lion Creek gains significant quantities of groundwater.

- Installation and monitoring of piezometers within the marsh area.

BVSPC conducted additional activities to fill data gaps from previous investigations. These activities included Geoprobe soil borings, a membrane interface probe (MIP) investigation and groundwater sampling. The information from these site investigations was used to conceptualize the site model.

2.4.4.2 Calculated Hydrogeologic Characteristics

In 1990, as part of the Phase I Remedial Investigation, Roy F. Weston conducted a 72 hour pumping test utilizing well OR6A as the pumping well and MW-11 and MW-12 as the observation wells. These wells were completed in the Upper Potomac Aquifer. In addition, water levels were recorded in 34 wells screened in the Columbia Aquifer. The purpose of the pump test was to determine hydraulic characteristics of the Upper Potomac Aquifer and to determine if vertical flow occurs through the silty clay and clay layer that was thought to separate the Columbia Aquifer from the Potomac. Based on the collected data, no connection between the aquifers was identified (Weston 1992). It has been noted that the sand pack for MW-11 and MW-12 differ in length and that this difference could indicate that they are screened across different sand formations (DNREC, 2003). Results of recent groundwater quality analyses – discussed in Section 2.5.5.1 – performed on a sample collected from a Potomac Formation monitoring well (installed downgradient of the SCD facility) indicate that there might be a hydraulic connection between the two aquifers.

In 2001, as part of the PRP's remedial design process, Conestoga-Rovers & Associates conducted aquifer testing utilizing monitoring wells and recovery wells completed in the Columbia Aquifer. The purpose of the test was to develop aquifer characteristics for the groundwater model that would be used to test various remedial design options. A new observation well, OBS-1, was installed for the test. In addition, a stream piezometer, TP-1, was installed in the marsh area just north of MW-25 to determine if there was any influence on the marsh water level.

A summary of calculated hydraulic properties from the two testing programs is presented in Table 2-1.

2.4.4.3 Water Levels and Flow

Shallow groundwater flow in the Columbia Aquifer under the SCD facility is controlled by the topography and wetland areas around Red Lion Creek. Shallow flow is predominately to the north toward Red Lion creek. The deeper groundwater flow in the Upper Potomac Aquifer is controlled by the regional recharge areas and discharges to the Delaware River in the regional flow system. The Upper Potomac flow is generally to the southeast toward the Delaware River.

Groundwater level measurements were collected from the extensive groundwater monitoring well networks on and off-site. Based on the data, the shallow groundwater has an elevation of about 14 ft above MSL in the upland area near the facility and 4 ft MSL near the unnamed tributary and Red Lion Creek. Measurements collected in 2001 during the operation of the recovery wells indicated an induced depression that extended along the line of the RW wells and had an elevation of 0 ft MSL (CRA 2001). However, since the RW wells are currently inactive, it is assumed that this depression is no longer present.

Groundwater elevations in the Upper Potomac range form about 5 ft MSL near OR6A and 1.5 Ft MSL near MW-11 and MW-12. Weston noted an upward gradient between the two aquifers in the area of Red Lion Creek and the unnamed tributary and a downward gradient in the upland area under the SCD facility (Weston 1992).

2.4.4.4 Yields

Recovery wells, RW-1 through RW-4, maintained average individual flow rates of between 10 gpm and 21 gpm during the years in which the groundwater collection system operated (CRA 2001). The only Potomac Aquifer well yield noted in previous work was for well OR6A at 410 gpm for 74 hours.

2.4.4.5 Groundwater Modeling

Based on available site-related data, BVSPC compiled a groundwater model for the SCD facility which is presented in Appendix A. Four alternative containment systems (together with the No Action Alternative) were developed and modeled. Conclusions from the report include the following:

- Contaminated groundwater will migrate and discharge into the Red Lion Creek and its unnamed tributary indefinitely unless the source area is remediated or containment is achieved.

- Both of two containment wall alternatives developed (Metachem Boundary Wall and Extended Wall) provided better protection of groundwater with pumping wells than with interceptor trenches.

- The Extended Containment Wall with Interceptor trench requires the largest contaminated groundwater extraction of the four action alternatives.

- The Metachem Boundary Wall with interceptor trench provided the least protection of the four interim remedial action alternatives that were evaluated. The alternative may allow some contaminated groundwater on the southeast side of the present plume to escape to outside the wall areas.

- The Extended Containment Wall with pumping wells provides provided the best protection to groundwater. The system was evaluated with eight pumping wells that extracted groundwater at a total rate of 158 gpm.

As stated earlier, the groundwater model will be revised/modified to take into account findings from the recent Potomac well sampling and an upcoming geotechnical investigation and any impact these findings have on the proposed wall placement. Results of this updated model will be included in the Intermediate Basis of Design/Design Criteria Barrier Wall Addendum.

2.5 Groundwater Characterization

The quality of the groundwater underlying the SCD Site was characterized through sampling events conducted as part of the RI, during preliminary remedial design investigations performed by Metachem, during a 2002 DNREC investigation, and as part of BVSPC's RD investigation. Details from these investigations are summarized in the following sections.

2.5.1 Remedial Investigation

During the RI, SCD's contractor collected Columbia and Potomac Formation groundwater samples from monitoring and recovery wells located across the SCD Site and surrounding properties, as well as from well points located adjacent to the Red Lion Creek (Weston, 1992). A total of 82 samples were collected from 37 wells and three well points screened in the Columbia aquifer. Additionally, five samples were collected from four wells screened in the Potomac Aquifer. Complete details of the RI sampling effort are provided in the 1992 RI Report submitted by the PRP.

2.5.2 Metachem Design Investigations

Between 1999 and 2001, the PRP (through its contractor) conducted a Remedial Design Investigation (RDI) and a Supplemental Remedial Design Investigation (SDRI) in an effort to obtain data for use in the design of a containment barrier and extraction/treatment system. While the following sections summarize the methods and findings from these investigations, complete details can be found in the RDI and SRDI Reports that were submitted by the PRP.

2.5.2.1 Groundwater Investigation

As part of their RDI efforts, the PRP conducted a groundwater investigation to further characterize the nature and extent of the COC contamination in the groundwater underlying the SCD facility and adjacent properties. A total of thirteen borings were installed into the Columbia Aquifer at locations on the Air Products Facility, along the potential barrier wall alignment area, and to the north of Red Lion Creek. Six of these borings were converted to monitoring wells (MW-24, MW-25, and MW-33 through MW-36). These borings and wells were installed in accordance with the PRP's Remedial Design Work Plan (RDWP). Groundwater samples were collected from a total of 39 new and existing wells at the SCD Site and analyzed to further characterize COC contamination (CRA, 2000). During the PRP's SRDI, three additional monitoring wells (MW-37 through MW-39) were installed – in accordance with the PRP's RDWP – into the Columbia Aquifer north of Red Lion Creek. During this SDRI, groundwater samples were collected from existing wells MW-34, MW-35 and MW-36 as well as from the three newly installed wells (CRA, 2001).

2.5.2.2 Dense Non-Aqueous Phase Liquids Investigation

The PRP's 2000 dense non-aqueous phase liquid (DNAPL) investigation was conducted in two areas of the plant at which DNAPL was suspected from previous investigations to be present in the vicinity of wells TW-5 and TW-30. This investigation included installation of seven borings in the vicinity of existing wells TW-5 and TW-30. These seven borings were converted to monitoring wells (MW-26 through MW-32). A DNAPL screening evaluation was conducted on these new wells using an interface probe and depth-discrete sampling with a Kemmerer sampling device. Soil samples from these locations were also collected and tested with Sudan dye. Based on the results of these initial tests, DNAPL recovery tests were performed on wells MW-28 and TW-30 using a pneumatic pump. Samples collected at this time were sent to an off-site laboratory for physical characterization of the DNAPL (CRA, 2000).

2.5.3 2002 DNREC Investigation

In August and September 2002, DNREC collected a total of 33 groundwater samples from 27 monitoring wells, three former recovery wells, and one well point located on the SCD property. In addition, single groundwater samples were collected from three wells on the Air Products property and five monitoring wells on the Oxychem property immediately to the east of the SCD property. All of these samples were analyzed for VOCs and SVOCs.

2.5.4 BVSPC RD Investigation

As part of Remedial Design field activities, BVSPC performed a multi-phased investigation of the geology and groundwater underlying the SCD Site. This investigation included initial screening with a membrane interface probe/electrical conductivity (MIP/EC) unit, follow-up groundwater sampling, and installation of Flexible Liner Underground Technologies (FLUTe) Liners for detection of non-aqueous phase liquids (NAPLs).

2.5.4.1 MIP/EC Screening

The MIP employed a photoionization detector (PID), a flame ionization detector (FID) and an electron capture detector (ECD) to identify site-related contaminants. Although these detectors are not capable of determining the species or exact concentration of contaminants at any one location, they do provide an indication of the relative levels of contamination throughout the site. The results of the associated electrical conductivity (EC) study were used to evaluate the continuity of the clay layer that separates the Columbia Formation from the Upper Potomac Formation (the clay layer) at the site. To gain insight as to the northern extent of the groundwater plume at the site, a series of MIP/EC points were placed along the southern border of the Red Lion Creek (locations C14 through C24 on the MIP/EC data output). Other MIP/EC locations were also selected based on their potential to identify potential NAPL pools, and to provide added information regarding contamination extent and clay layer continuity.

The results from the detectors were compiled and plotted using the RockWorks2002 software package. Printouts of the resulting output and interpretation of these data are included in Appendix B.

2.5.4.2 Groundwater Sampling

Following completion of the MIP/EC study, groundwater samples were collected from 12 MIP locations and one soil boring location. The locations and depths from which these samples were collected were chosen based on the results obtained from the MIP detectors and field observations made by BVSPC personnel. All of the collected samples were analyzed in an onsite laboratory provided by Sentinel Mobile Laboratories. Split samples were collected from four of the locations and shipped to a contract laboratory program (CLP) lab to verify the onsite lab's results.

Additional groundwater samples were collected from Geoprobe borings installed to the north of the Red Lion Creek and to the west of the Red Lion Creek's unnamed tributary. Two of these borings were installed to the north of Red Lion Creek adjacent to monitoring wells MW-34 and MW-36. Another boring was installed approximately 100 feet to the west of MW-34. Six additional borings were installed along a line approximately 100 feet to the north of monitoring wells MW-34 through MW-38 on the Motiva property located immediately to the north of Red Lion Creek. A total of 10 samples were collected from these nine locations. Five borings were installed along the access road located on the Motiva property to the west of the unnamed tributary, but groundwater samples could only obtained from two of these. These samples, collected from the Columbia Aquifer, were taken to determine the extent to which the site-related contaminants had migrated beyond the two water bodies.

In an effort to obtain additional information on the impact of Columbia Aquifer contamination on the underlying Potomac Aquifer, a new monitoring well (PW-1) was installed to the east of the SCD facility in the area of MW-15. This location was selected because Potomac Formation flow patterns place it downgradient of the SCD facility, and is thought to be outside the Columbia Formation groundwater contamination plume. A sample was collected from this well on November 14, 2003 and was analyzed for VOCs and SVOCs.

2.5.4.3 Surface Water Sampling

BVSPC was tasked with conducting preliminary surface water sampling of the Red Lion Creek and its unnamed tributary. This sampling was performed to determine to what extent the water quality in these bodies have been impacted by the presence of site contaminants in the groundwater.

In an attempt to determine how water quality varies with depth in the Red Lion Creek, BVSPC personnel initially tried to collect water column samples from the creek using a Kemmerer Sampler. Because of the shallow nature of the creek, it was only possible to obtain multiple depth samples from one of the three sample locations. Grab samples were collected from the other two locations using regular sample bottles. Grab samples were also collected from both of the sampling locations in the tributary. A total of seven samples (including one duplicate) were collected and shipped to a USEPA designated CLP lab.

2.5.4.4 FLUTe Liners

Following the MIP/EC screening, NAPL FLUTe liners were installed at four locations selected because of elevated readings from MIP detectors and/or evidence that the underlying geologic had the potential for DNAPL accumulation. Locations selected for liner installation included areas near two MIP points (C-11 and C-12) as well as two locations above previously identified low points in the base of the Columbia formation (near monitoring wells MW-1 and MW-3). A fifth liner was installed to the east of monitoring well MW-6. This location was selected based on intense staining observed on the liner installed near MW-3 and historical evidence suggesting the presence of a trough in the clay layer leading from the area under the sedimentation basin towards Red Lion Creek. In each case, the liner was installed to the depth of the clay layer.

The liners were installed by using a Geoprobe to probe to the appropriate depth and then inserting the uninflated liner down through the geoprobe rods. The rods were extracted from the ground leaving the liner in place. Air and water were then pumped into the liner to inflate it. Each liner was left in place for at least one hour before being removed. After being removed, the liner was cut open and examined.

2.5.5 Nature and Extent of Contamination

Results from each of the investigations show that extensive contamination exists in the Columbia Aquifer groundwater underlying the SCD Site.

2.5.5.1 Nature and Extent of Dissolved COC Contamination

RI SAMPLING DATA: The results of the RI sampling effort showed that there is extensive site-related contamination of the Columbia Aquifer in the area underlying the SCD facility and extending northward to the Red Lion Creek. According to the RI Report, the highest levels of site-related contaminants were observed between the areas of the two major documented releases (1981 and 1986) and recovery well RW-2. Only limited amounts of COCs were detected in samples collected from wells located on the Air Products property adjacent to the SCD facility's western boundary and the Occidental Chemical property located to the east of the facility.

No site-related contaminants were identified in any of the five samples collected from the Potomac Aquifer. None of the wells from which these samples were collected are located on the SCD facility.

PRP RDI/SDRI SAMPLING DATA: During their investigations, sampling by the PRP showed elevated concentrations of COCs in the groundwater underlying the northern three-quarters of the fenced portion of the SCD property and the area between the facility fence line and Red Lion Creek. Analysis of samples from these areas showed the presence of seven of the 16 COCs at concentrations higher than their respective drinking water maximum contaminant levels (MCLs). North of the facility fence line, two wells (TW-50 and MW-25) had notably higher COC concentrations than other wells in this area. Within the facility fence line, higher concentrations of the COCs were found in groundwater samples collected near the source areas of the railroad siding and Catch Basin No. 1.

In general, COCs did not exceed MCLs in the Columbia Aquifer samples collected from locations north of Red Lion Creek or from wells located on the Air Products and Oxychem properties that are adjacent to the SCD facility. In samples collected from the area north of Red Lion Creek, only one sample (collected from MW-36) had a COC (benzene) present at concentrations greater than its MCL. Site-related contaminants were detected in samples from two of the three wells on the Air Products property, but none of the COCs were present at concentrations greater than their respective MCLs. Site-related contaminants were also detected in three of the five sampled wells on the Oxychem property located immediately to the east of the SCD facility, but only 1,4-dichlorobenzene was detected (in MW-17) at concentrations greater than an established MCL (CRA, 2000). During the PRP's SDRI, no VOCs were detected in the sampled wells (located north of Red Lion Creek) with the exception of toluene. There were also no SVOCs detected in these wells (CRA, 2001).

DNREC SAMPLING DATA: Additional groundwater data was obtained from a sampling event conducted in late August/early September by Delaware Department of Natural Resources and Environmental Control. This event included samples from 33 wells located across the Metachem/SCD property, as well as three wells on the Air Products facility to the west, five wells on the Oxychem property to the east, and two wells located on Motiva property to the north of Red Lion Creek.

Analyses of samples collected from the wells on the Metachem/SCD Property showed that there is significant contamination across the SCD Site with every sample having at least one (and almost always more than one) COC detected at concentrations greater than its MCL. Total COC concentrations were greater than 5 mg/l in samples collected from all but two locations (TW-1 and TW-3) across the site. The average total concentration of COCs detected in the samples from the Metachem/SCD property was 158.41 mg/l, with a high reading of 2,855.3 mg/l at MW-28 and a low of 0.214 mg/l at TW-1.

Samples collected from the Air Products wells (MW-10, MW-13, and MW-33) showed relatively low levels of site-related contaminants with concentrations of each COC less than 8 ug/l in all samples.

Samples collected from the southern Oxychem wells (MW-14 and MW-15) each had total COC concentrations less than 5 ug/l. Contaminant concentrations were higher in samples collected from the two northern Oxychem wells with total COC levels of 609 ug/l and 4,155 ug/l at MW-18 and MW-17, respectively. Benzene, chlorobenzene and 1,4-dichlorobenzene were the primary contaminants at MW-18, while mono-, di-, and trichlorobenzenes predominated at well MW-17. There were no COCs detected in the sample collected from the Potomac Aquifer well (MW-12) located on the Oxychem property.

The limited DNREC sampling conducted to the north of Red Lion revealed only low concentrations of tetrachlorobenzene compounds (approximately 1 ug/l each) detected in the two samples collected from the wells (MW-34 and MW-36). Subsequent sampling performed by DNREC to confirm these results failed to detect any contaminants in these wells.

COC data from the DNREC sampling event are included on Table 2-2 and are presented with the respective sample locations on Figure 2-2.

BVSPC MIP/EC DATA: Results from the MIP portion of this investigation indicated that extensive contamination is present throughout much of the area underlying the SCD Site. Raw instrument data plots and interpolated contaminant contour maps for the three detectors are included in Appendix B of this Report.

Evidence of the presence of a clay layer separating the Columbia and Potomac Aquifer was provided by the results from the EC portion of the investigation. As with the data from the MIP detectors, the EC data was plotted using RockWorks2002. A plot of the raw EC data and the interpreted lithology fence diagram are included in Appendix B of this Report.

BVSPC GROUNDWATER SAMPLING DATA: In three out of the four split samples analyzed, total COC concentrations from the mobile lab analyses were lower (by an average of 37%) than the associated results from the CLP lab analyses. Only in the sample with the lowest level of contamination was this trend reversed.

With this in mind, the results of the groundwater sampling did show that, as predicted by the MIP detectors, contamination is widespread throughout the portion of the Columbia Aquifer that underlies the site. Highest levels of contamination were found in samples collected from beneath the central portion of the facility, to the north of the sedimentation basin, and at the northwest corner of the wooded area beyond the facility fence line (location C-14).

Further analysis of the groundwater data from this sampling event shows that benzene, chlorobenzene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene make up an average of approximately 79% of the detected site contaminants in each sample. 1,2,4-trichlorobenzene and 1,3,5-trichlorobenzene generally make up the bulk of the remaining COCs found in the samples. The percentages for the trichlorobenzene isomers are much higher in the three samples with total COC concentration less than 5 mg/l and in one deep sample collected at location C-11.

No site-related contaminants were detected in any of the samples collected from the Geoprobe borings installed to the north of Red Lion Creek and to the west of the unnamed tributary.

Preliminary, unvalidated results from analysis of a sample collected from the monitoring well that was recently installed into the Potomac Aquifer indicate the presence of low levels (relative to those found in the majority of samples taken from the Columbia

Aquifer) of four COCs. Only benzene was present in this sample at concentrations above its MCL.

COC data from BVSPC groundwater sampling efforts on the SCD property are included on Table 2-2 and are presented with the respective sample locations on Figure 2-2.

SURFACE WATER SAMPLING DATA: COCs were detected in all but one of the surface water samples that were analyzed. Contamination was substantially higher in the samples collected from the unnamed tributary (619 ug/l and 60,940 ug/l) than in those collected from Red Lion Creek (non-detect to 107 ug/l). This was expected, given the high levels of contamination observed in the sediments of the tributary area. In the Red Lion Creek samples, total COC concentrations appear to be related to sample location, with the highest concentration found in the eastern-most (downstream) sample and relatively low concentrations found in one of the two upstream samples. Because of the observed direction of groundwater flow in the Columbia Aquifer, this concentration trend seems to indicate that surface water quality in the creek is being impacted by both sediment and groundwater contamination from the SCD Site.

COC data from BVSPC surface water sampling efforts are included on Table 2-3.

RESULT SUMMARY: Data from the DNREC sampling and the BVSPC groundwater sampling event were used as inputs for the base condition of the contaminant transport model that has been developed for the SCD Site. When these data were input and an initial set of contours developed, the contaminant plume extent was determined to be similar to that depicted in the study conducted during the 1992 RI. In addition, while notable concentrations of site contaminants were found in most of the surface water samples collected from the Red Lion Creek and its tributary, no such contamination was detected in groundwater samples collected to the west of the tributary, and COCs were either not detected or only detected at minimal levels in the groundwater samples collected from north of the Red Lion Creek. Taken together, this information indicates that the contaminant plume is largely stable with Red Lion Creek and its tributary apparently acting as natural buffers against the northward and westward movement of the groundwater contaminant plume.

Preliminary results from the most recent sample – collected from the Potomac Aquifer – indicates that some site-related contamination might have passed from the Columbia Formation down into the Potomac Formation. Because these results have not been validated and no confirmation sampling has been performed to this point, the results should be viewed with caution and will not be used as the basis for design decisions at this time. The results of this sampling event are currently being validated by the EPA. Additional sampling of this and other Potomac monitoring wells is being performed during December 2003 to confirm this result.

2.5.5.2 Nature and Extent of DNAPL Contamination

PRP RDI RESULTS: During the PRP's investigation, interface probe measurements and Kemmerer samples revealed DNAPL in well MW-28 only. Screening of the soil samples with Sudan Dye revealed the presence of DNAPL just above the top of the confining layer in well MW-28 and well TW-30. Based on their study, the PRP concluded that a thin zone of DNAPL is present in the vicinity of the source areas and that a small isolated pool of DNAPL exists in a localized confining unit depression near well TW-30. During the DNAPL recovery tests conducted at MW-28 and TW-30, pumping rates of less than 0.4 to 0.065 gpm could not be maintained for more than 20 to 25 minutes (CRA, 2000).

BVSPC FLUTE LINER RESULTS: Three of the five FLUTe liners installed showed varying degrees of staining indicating the presence of NAPL at the locations. The liners installed at MIP/EC locations C-11 (near the truck loading area adjacent to the rail siding) and C-12 (near the WWTP's aeration basin) showed moderate staining between 50 to 55 feet bgs and 50 to 51 feet bgs, respectively. Intense staining was observed between 56 and 61 feet bgs on a liner installed just to the north of the site's sedimentation basin (near monitoring well MW-3). No staining was observed on liners installed near monitoring well MW-1 and MW-6.

ADDITIONAL RESULTS: Based on known solubility limits of some of the COCs in water, COC concentrations in certain groundwater samples collected by DNREC and BVSPC provide additional evidence that DNAPL might be present at some locations. In particular, analysis of the DNREC groundwater samples collected from monitoring well MW-28 revealed the presence of 1,2,3,4-tetrachlorobenzene, 1,2,4,5-tetrachlorobenzene, and pentachlorobenzene at concentrations that exceed these chemicals solubility limits in water. Similarly, concentrations of the two tetrachlorobenzene compounds exceeded their respective aqueous solubility limits in one DNREC sample collected from monitoring well MW-29 during DNREC's 2002 investigation. Four compounds (1,2,4-trichlorobenzene, 1,3,5-trichlorobenzene, 1,2,3,4-tetrachlorobenzene, and 1,2,4,5-tetrachlorobenzene) were detected at concentrations somewhat greater than their aqueous solubility limits in the deep sample collected by BVSPC from MIP/EC location C-11.

2.5.6 Well information and Soil Boring Logs

All available well logs and soil borings for the site are presented with the MIP/EC output in Appendix B.

3.0 Project Description

3.1 Groundwater Remedial Objectives

No specific cleanup goals were established for the site contaminants of concern as part of the interim remedy. Although MCLs are not considered ARARs for interim groundwater remedies under CERCLA, they are frequently used in determining cleanup levels for final stage remedies. These and other state and regional regulations can be considered potential ARARs and should therefore be considered in the Interim Groundwater Remedy RD. Table 3-1 presents chemical specific limits that might be taken into account when developing final groundwater cleanup goals. In addition, these limits will possibly play a role in determining discharge limits that will be put in place to meet the substantive requirements of the National Pollutant Discharge Elimination System (NPDES).

The ROD states that "restoration of groundwater to drinking water standards where DNAPLs are present may not be technically practicable" (ROD, 1995). Instead, the ROD cites the following objectives for the Interim groundwater Remedy:

- Prevent exposure to the contaminated groundwater;
- Prevent further migration of the contaminated groundwater;
- Prevent further degradation of the unnamed tributary to Red Lion Creek and of Red Lion Creek;
- Remove DNAPL pools, if identified during the RD, which act as a continuing source of groundwater contamination.

The ROD also specifies that additional data will be collected during the interim action to, "determine the extent of DNAPL and groundwater contamination." As mentioned above, both DNREC and EPA Region III (through its contractor BVSPC) have collected – and continue to collect – additional data regarding the water quality of the groundwater underlying the site and its impact on the surrounding surface water. Based on the additional data accumulated as part of the interim action, EPA will determine the, "technical practicability of remediating the groundwater to health based levels," and subsequently decide on a final remedy for the groundwater. A final ROD that specifies the final goal and anticipated timeframe for the groundwater remediation will then be prepared by the EPA (ROD, 1995).

3.2 Preferred Remedial Alternative

Two remedial alternatives for groundwater were presented in the ROD. EPA evaluated these alternatives as well as the No Action Alternative against the nine criteria specified in the National Oil and Hazardous Substance Pollution Contingency Plan at 40 CFR § 300.430 (e)(9)(iii). The EPA preferred remedial alternative involves the following components:

- Implementation of institutional controls in the form of deed restrictions on the affected properties;
- Maintenance (or replacement, if necessary) and operation of the existing groundwater extraction wells. These wells have become inactive and will only be replaced if determined to be necessary for plume capture or hydraulic head control;
- Treatment of extracted groundwater with the facility's existing air stripper (if available) and discharge of treated water to the Delaware River under the facility's existing NPDES permit. Because of recent facility closure and impending decommissioning of the existing facility WWTP, this design document will assume that a new treatment plant – incorporating filtration, air stripping, and carbon adsorption for organics removal – will be constructed at the Site for treatment of extracted groundwater. Additionally, the closure of the WWTP and past problems with the plant's existing discharge line will require the installation of a new discharge line to the Red Lion Creek along with a new NPDES equivalent permit for the discharge;
- Treatment of air emissions in the facility's existing boilers (if available). Because the existing boilers will be shut down in conjunction with the decommissioning of the WWTP, additional controls will have to be put in place to treat air emissions from any groundwater treatment system that is implemented. Because of state restrictions on the placement of thermal oxidizers in the coastal plain this design includes vapor phase carbon units for off-gas treatment;
- Installation and operation of low volume product recovery wells with off-site disposal of recovered DNAPL in accordance with RCRA. Three low volume product recovery wells and collection systems;
- Installation of a groundwater containment system – consisting of a physical barrier such as an interceptor trench, sheet pilings, or slurry wall – along the shorelines of the unnamed tributary and Red Lion Creek;

- Installation of other measures (e.g., additional groundwater extraction wells) to ensure that the elevation of the Columbia Aquifer does not exceed the seasonal high groundwater table that existed prior to construction of the barrier. This design includes eight new extraction wells to be placed near the proposed containment barrier;

This design document addresses the above components.

3.3 Intermediate Design

The major components of the design for this site are the physical barrier, groundwater extraction wells, DNAPL recovery systems, treatment system, the treatment building, and conveyance systems. The overall design of the containment/extraction system was based in part on the results of the groundwater model included in Appendix A. The presented design is based on the Extended Wall with Wells alternative that was schematically developed in the groundwater model report (Appendix A), but the wall has been realigned slightly to minimize encroachment on neighboring property and to improve overall constructability of the barrier wall. A revised groundwater model that takes into account this realignment will be developed and incorporated into the aforementioned barrier wall addendum.

3.3.1 Site Development

For the preliminary design, topographic surveys were obtained for the SCD Site. The resulting base map has been incorporated into the attached intermediate site plans that are presented in Appendix G.

The majority of the area where the barrier and treatment building are to be constructed is wooded. Portions of these areas will require clearing and regrading prior to construction. If not previously addressed as part of the Soil/Sediment remedial action, the access roads located to the north of the facility fence line will need to be upgraded to handle construction traffic. Trenching will be required to install conveyance piping from the wells to the treatment building and from the treatment system to the discharge point on the banks of the Red Lion Creek. To minimize the length of discharge piping and address concerns regarding the impact of site contamination on construction activities, the treatment system building will be located in an undeveloped portion of the area to the north of the facility fence line. This location will also minimize the effect of construction activities on facility remedial operations. Utilities, including potable water and electricity, will be routed to the treatment building and extraction wells from existing facility connections.

3.3.2 Extraction Wells

Available information from the RI, the PRP's RDI, and the PRP's SRDI indicates that suitable water bearing zones should be encountered at each of the projected extraction well locations. Use of eight (8), 6 inch diameter extraction wells is anticipated with each well installed to a depth of between 25 and 60 feet bgs. Because of possible chemical and pH compatibility issues, these wells will be constructed of 304 stainless steel. If subsequent sampling leads to the conclusion that groundwater chloride levels are too high, it might be necessary to substitute 316 stainless steel (which is approximately 30% more expensive but is more resistant to attack by chlorides) for all well construction applications.

The anticipated well depths and screening intervals are based on boring log information and electrical conductivity data showing the presence of a clay layer that separates the Columbia and Potomac formations at approximately those depths. The six inch wells will be installed by drilling a 10 inch diameter hole to allow room for sand pack and grouting. Approximately 10 feet will be screened with 0.020" slotted stainless steel and a #01 Morie sand pack. Because MIP/EC data, other historical sampling data, and the general nature of the contamination (largely DNAPL) suggest that heaviest contamination will be encountered at or just above this clay layer, the extraction wells will be screened from the clay layer up. The remaining length of the well will be grouted with a bentonite/cement grout. Installation will include a 3 ft x 3 ft x 3 ft traffic rated and waterproof vault box for each well. All of the necessary drilling is expected to be through unconsolidated overburden material consisting of sand and silty sand. From past drilling experiences in the field, advancing the auger at these locations will not require special drilling techniques.

The groundwater model (Appendix A) assumed extraction rates of between 10 and 30 gallons per minute (gpm) at all pumping locations. Historical pumping rates from the five recovery wells on the Metachem/SCD property – as well as those on surrounding properties – suggest that these rates should be achievable. It is estimated that the total extraction rate for the eight wells will be approximately 158 gpm. Additional groundwater modeling might be completed and could result in a revision of these estimates. The actual flow rate encountered during well installations might also require that this rate be adjusted. If the any of the proposed extraction rates are determined to be unrealistic, additional wells might be required to meet the desired total system extraction rate. Based on an anticipated flow rates, a submersible well pump (equivalent to Grundfos pumps) – each equipped with a motor rated at between 0.5 and 5 horsepower (hp) – would be installed at each location and include wiring and instrumentation. In determining pump sizes, a safety factor of 30% was applied to the anticipated well flow rates resulting in a total design system extraction rate of 210 gpm. Friction head calculations that were used in pump selection are included in Appendix C.

In addition to the groundwater extraction wells, it is anticipated that three product recovery wells will be installed at the SCD Site. Each product recovery well will be constructed with its bottom located slightly below the top surface of the clay layer separating the Columbia and Potomac aquifers. As with the groundwater extraction wells, these product recovery wells will be designed and constructed in accordance with appropriate DNREC requirements. As with the groundwater extraction wells chemical and pH compatibility issues will necessitate the use of stainless steel or some resistant plastic such as PVDF or FEP in the construction of these wells. A low volume stainless steel product recovery pump with Teflon seals (or equivalent) will be positioned at the bottom of each product recovery well with a discharge line routed to a product separation/collection system that will consist of a barrel containing NAPL adsorbent material (such as an anthracite clay media) and a water collection drum located on a secondary containment pallet. This product separation/collection system will be positioned adjacent to the well and will be emptied periodically by operations workers. The use of separate collection vessels (as opposed to using conveyance piping to connect the recovery wells to a central collection location) was selected because of high projected piping installation costs relative to the anticipated product recovery volume. Recovered product will be handled in accordance with all relevant state and federal regulations. The product will be packaged in an appropriate Department of Transportation (DOT) container, manifested and labeled in accordance with all RCRA and Delaware hazardous waste regulations, and shipped off-site for disposal at a RCRA-permitted facility.

3.3.3 Treatment Systems

Section 2.5 discusses the groundwater characterization and contaminants of concern for the SCD Site. Table 3-1 provides the relevant regulatory limits that might be used in determining cleanup goals and/or NPDES discharge limits for the treatment system. A new NPDES equivalent permit will be acquired for the treated water discharge to the Red

Lion Creek. The clean up goals for COCs and permit requirements for metal and organic contaminant discharges will determine the groundwater treatment required by the system. Air permit requirements will determine any air treatment. Sizing for the air stripping, liquid phase carbon, and vapor phase carbon portions of the proposed system was performed using Carbonair's STAT, Liquid Phase Carbon, and Vapor Phase Carbon models, respectively.

The following is a list the anticipated treatment components required for the treatment system. Redundant process pumps are included in the design to minimize any potential downtime due to malfunction or maintenance requirements. A more detailed description of the treatment system design is presented in specification Section 11430 and on drawings GP-2 through GP-5.

- Influent holding tank.
- Initial Filtration System – Two bag filters sized to handle at least 210 gpm fed by a 10 horsepower (approximate) feed pump from the influent tank.
- Hardness Conditioning Unit (if necessary) – to soften the groundwater prior to air stripping. Depending of groundwater hardness levels obtained in subsequent sampling, this might not be necessary in the system.
- Air Stripper – A low-profile tray (4 trays) type air stripper capable of treating at least 210 gpm and equipped with a blower rated for approximately 3,500 cubic feet per minute (cfm). A low-profile tray stripper was selected to ensure ease of maintenance/cleaning.
- Vapor Phase Granular Activated Carbon Units – Two 14,000 lb (approximate) units, in series, to remove organics from the air stripper off-gas, preceded by a duct heater to serve as humidity/temperature control for the air flow from stripper.
- Secondary Filtration System – Two bag filters sized to handle at least 210 gpm fed by a 10 horsepower (approximate) feed pump from the air stripper.
- Liquid Phase Granular Activated Carbon Units – Two units (approximately 5,000 lb capacity each) capable of handling at least 210 gpm in series to serve as a polishing step for secondary removal of organics prior to discharge.
- Treated Water Storage Tank (temporary)
- Programmable Logic Controller (PLC) and a Supervisory Control and Data Acquisition (SCADA) system.

Ultraviolet (UV) oxidation was considered for treatment of the contaminated groundwater, but was eliminated after discussions with vendors indicated that the technology would not be cost effective in this application. Elimination of the air stripper and vapor phase carbon units in favor of larger liquid phase carbon units was considered in an effort to simplify the treatment system, but this choice was rejected because of substantially higher projected carbon usage and long term operating costs. High rate anaerobic treatment (fluidized bed reactor) was rejected because of higher operator skill levels and long recovery times that are typical in the case of failure of such systems.

Thermal and catalytic oxidation were both considered for treatment of the air stripper off-gas, but have been ruled out (at least temporarily) because of the prohibition on the use of these technologies in the Delaware Coastal Plain (discussed in Section 5.1.2). If a subsequent state interpretation of the coastal plain regulations reveals that an oxidizer could be sited at the SCD property, one or both of the off-gas oxidation technologies might be revisited. While the capital costs associated with these technologies were projected to be approximately 3.5 to 4.5 times that of the vapor-phase carbon units, initial vendor estimates of operating costs show that a payback period of less than two years could be achieved. The use of catalytic oxidation (which has lower capital and operating costs than thermal oxidation) might be impractical because of the possibility that the presence of relatively high levels of chlorinated compounds could damage the catalyst. Other off-gas treatment technologies that were considered included the use of a condenser and destruction by routing the gas through an internal combustion engine. These technologies were discarded after an initial review of their capabilities relative to the projected off-gas concentrations and flow rate.

As mentioned above, the data gathering effort continues at the SCD Site. The results of this process could identify additional design needs for the treatment system. In addition, effects (e.g., decrease in groundwater contaminant levels) related to any use of an in-situ treatment technology to address subsurface soil contamination beneath the facility could prompt some modifications to this design. Finally, because this treatment system design is based on estimates of permit limits, it might require further modification to achieve discharge and/or air permit compliance.

3.3.4 Treatment Building

A treatment building will be installed at the site and will be sized to house the treatment system described. It is expected that a 50 ft by 45 ft building footprint will be required. To ensure ease of installation and maintenance, and insulated steel wall building (Butler or equivalent) will be constructed on a concrete slab foundation at the site. The building will be placed to the north of the existing sedimentation basin at a location that is expected to be relatively free of surface soil contamination and is generally level. This placement location was selected to minimize the overall system construction cost (including road installation, site preparation, and conveyance piping costs) and to reduce the impact of construction and system operation on the other remedial activities being carried out at the site.

3.3.5 Conveyance Systems

Subsurface pipe installation will be constructed from extraction well to the treatment building and from the treatment building to the discharge location. Pipe trenches will be approximately 3 ft to 4 ft deep with sand/fine gravel pipe bedding. The remaining backfill can be material previously excavated to form the trench. Backfill should be compacted to 95% of standard proctor densities. Various diameter stainless steel pipe will be used from the extraction wells to the treatment building. Conveyance pipe diameters (ranging from 2 inches where the flow is the lowest to 4 inches for the header that connects to the treatment system) were determined by balancing the increases in head loss due to friction against the higher costs of larger diameter piping. Within the treatment plant, primarily 3 inch 304 stainless steel piping will be employed. As with well construction materials, 316 stainless steel (which is approximately 30% more expensive but is more resistant to attack by chlorides) might be required for all groundwater conveyance and treatment process piping applications if groundwater chloride levels are determined to be too high. The decision not to use polyvinyl chloride (PVC) for these lines was made because of serious concerns about the ability of PVC to resist degradation by the chlorinated benzene compounds present in the groundwater. Carbon steel piping was rejected because of concerns about the corrosive effects of low pH groundwater present at the site. Single wall piping will be used because the added cost of double wall stainless steel piping

Because compatibility issues are not expected to be a problem with the treated water, it is expected that a 4 inch PVC pipe will be used for the discharge line running from the treatment building to an energy dissipation feature (such as a reno mattress) that will be constructed at the outfall on the banks of the Red Lion Creek.

The extraction piping trench will also contain the power and control wiring for the extraction pumps.

Pipe sizing calculations on which the piping choices were made are included in Appendix C.

3.3.6 Containment Barrier Wall

To prevent the contaminated groundwater underlying the SCD Site from reaching the Red Lion Creek, a soil-bentonite slurry wall will be installed to the north of the facility fence line. This containment barrier will be approximately 2 to 4 feet thick and will be keyed into the clay layer separating the Columbia and Potomac formations. A soil cap will be installed over the barrier to preserve its integrity and structural pass-throughs will be added to allow vehicle traffic to cross at specified locations. In developing the preliminary design of the containment barrier wall, constructability was taken into account along with the results of the groundwater model for the site. A more detailed discussion of the containment barrier wall is presented in the Design Memorandum included as Appendix D.

Approximately seven monitoring wells will be installed at various locations on the downgradient side of the barrier wall. These wells – in addition to the existing wells along the southern edge of the Red Lion Creek – will be used to monitor the performance of the overall containment system.

It should be noted that because of unresolved issues related to the approach and schedule for the remediation of the SCD Site soils and sediments, there is the possibility that aspects of the containment barrier wall design (including its location and construction) might be modified. Additionally, the results of an upcoming geotechnical investigation will be integrated into the barrier wall design and could require changes in barrier wall alignment. These modifications will be covered in the barrier wall addendum to this report.

3.4 System Testing and Startup

Upon completion of construction of all components, a two-month long system startup and testing period is anticipated. It will consist of the following:

$ 5 days (8 hours/day) of closed loop operation of the system that is staffed for the entire duration. Potable water will be run through the system in a closed loop to work out any major system flaws.

$ Next, groundwater would be pumped from the extraction well and sent through the treatment system. The treated groundwater will be discharged into temporary, onsite storage tanks (Baker/Frac tanks) for daily analytical testing. Treated groundwater will be discharged into the discharge points once testing results indicate the water meets the appropriate NPDES discharge limits/surface water criteria. It is anticipated that the system will be operated in this fashion for 5 days (8 hours/day) and require staffing for the entire duration.

$ Upon successful completion of the above step, the treatment system will be operated for 8 hours/day for 5 days by pumping groundwater from the extraction wells for treatment and direct discharge of the treated water into the proposed Red Lion Creek discharge line. Daily sampling will be performed to assure that the treated water meets the appropriate NPDES discharge limits/surface water criteria.

$ Then the treatment system will be operated for 24 hours/day for 10 days by pumping groundwater from the extraction well for treatment and direct discharge of the treated water through the proposed Red Lion Creek discharge line. Daily sampling will be performed to assure the treated water meets the appropriate NPDES discharge limits/surface water criteria.

$ Air emissions from the subject system will be monitored throughout the startup procedure to ensure compliance with all air quality/air permit requirements.

All NPDES and air permit related sampling will be conducted by BVSPC personnel with assistance from RA construction contractor personnel.

3.5 Treatment System Performance Monitoring

Upon successful startup of the system described above, it is anticipated that the remediation subcontractor will be responsible for operations and maintenance of the system for two years, although the actual duration of the initial O&M period will be determined after further discussions with the EPA. All NPDES, groundwater, surface water, and air permit related sampling will be conducted by BVSPC personnel with assistance from RA construction contractor personnel. System performance criteria will be established that include permit compliance, inspection and maintenance schedules, and minimum system run times.

The ROD contains requirements for the monitoring of the groundwater containment and the DNAPL removal and containment systems. Long term monitoring of the site in accordance with the terms of an EPA-approved Operation and Maintenance (O&M) Plan is anticipated for between 15 and 30 years. The actual duration and frequency of the monitoring – along with the specific contaminants to be monitored – will be determined after further consultation with EPA and DNREC. The formal O&M Plan has not been developed as of yet and is not included as a component of this task of the RD.

Monitoring wells located immediately upgradient and downgradient of the containment barrier will be sampled, and water levels obtained, as part of any long term monitoring of the remedy. To ensure that sufficient coverage is obtained, additional monitoring wells will be installed along the downgradient side of the containment barrier wall. Samples will also be collected periodically from existing monitoring wells located to the north of Red Lion Creek. In addition, surface water samples will be collected from the Red Lion Creek and its unnamed tributary. Finally, samples will be collected from the influent, effluent, and at key points of the treatment system. All samples will be analyzed for target contaminant list (TCL) organics, additional site-related contaminants and degradation products, and target analyte list (TAL) metals. Extraction well flow rates will be measured and combined with the remaining data to evaluate the overall effectiveness of the remedy and identify any unforeseen impacts of the containment system.

4.0 Design Criteria

4.1 Introduction

The following sections outline design criteria for major components of the groundwater containment barrier and groundwater extraction and treatment system discussed in Section 3.3. The design criteria for the containment barrier wall and extraction wells are based primarily on the ROD goals for groundwater, but the discharge requirements anticipated for the treated groundwater will govern the treatment system process design.

4.2 Groundwater Cleanup Standards

The ROD for the SCD Site established the Groundwater Remedial Objectives as described in Section 3.1. However, the ROD further states that restoration of the entire contaminated portion of the aquifer associated with the SCD Site to drinking water standards might not be "technically practicable" under the Interim Remedy for the site. The ROD also does not establish specific groundwater cleanup limits for the Interim Remedy, leaving those to be developed in the Final Remedy for the site. Whereas the objectives of preventing contaminant migration and recovering DNAPLs will be taken into account in the design of the extraction and barrier systems, the anticipated air and water discharge criteria are used as the primary treatment system design criteria.

4.3 Treatment Standards for Discharge to Surface Water

Based on concerns expressed by EPA and the evidence of historical contamination related to the facility's existing WWTP discharge line, an alternative discharge line (including energy dissipation feature) leading to a discharge point along the Red Lion Creek will be constructed. This discharge will be required to meet the substantive requirements of the NPDES, under which maximum discharge limits will be set for each specific parameter. To estimate potential Red Lion Creek discharge limits for each of the site COCs, BVSPC will use the most stringent of facility's July 1, 1998 NPDES permit requirements, MCLs, Delaware's Water Quality Criteria, and the Delaware River Basin Commission Freshwater Objectives. The facility's existing NPDES permit limits (as presented in the PRP's RDI) are listed in Appendix E. The relevant limits from the remaining three sources are shown in Table 3-1. The final NPDES discharge limits for the Red Lion Creek discharge will not be available until a final determination is made by DNREC and the EPA.

There is a general lack of historical metals and hardness data for the groundwater at the SCD Site. Although metals data is available for some locations at the Oxychem facility to the east of State Route 9, the results for samples from this facility vary widely depending on sample location and could be affected by specific activities being conducted at that plant. A review of data for eight samples collected from the four wells located closest to the SCD Site shows that the metals concentrations were typically less than their respective MCLs and the levels listed for SCD's NPDES permit. The exceptions to this were for copper (which was detected in the blank for the samples), mercury (likely the result of Oxychem specific activities), zinc (in one sample), and thallium (slight exceedances in two samples and detected in the blank for three others). These data are included in Appendix E. Based on this information, it is not expected that metals removal process will be necessary in the treatment system. However, it is recommended that additional samples be collected from SCD locations to obtain a more accurate picture of the metals content and the hardness of the groundwater underlying the SCD Site. The results of these additional samples might indicate that metals are present at concentrations greater than limits that would be reasonably expected in a NPDES equivalent permit. In that event, an appropriate metals removal process would be incorporated into the design. In addition, high hardness levels might necessitate the modification of the sequestering process or addition of a hardness removal process to minimize fouling of the air stripper.

4.4 Treatment Standards for Discharge to Air

It is currently anticipated that the treatment system will discharge treated off-gas from the air stripping operation to the atmosphere. Therefore, this discharge will be required to meet the substantive requirements of the Delaware Regulations Governing the Control of Air Pollution and the Delaware Ambient Air Quality Standards, which will govern the maximum contaminant levels for each specific parameter. To estimate potential discharge limits for each of the site COCs, BVSPC used the facility's existing air discharge permit limits for Boiler Number 3. The facility's existing air emission discharge limits (as presented in the PRP's RDI) are listed in Appendix E. In conversations with Delaware's Air Quality Management Section, it was determined that 0.1 lb/hr of VOCs is sometimes used as a discharge limit for Superfund sites in Delaware. The final discharge limit will be determined by DNREC (likely after consultation with the EPA).

4.5 Treatment Process

Contaminated groundwater will be pumped from the extraction wells to the treatment system via subsurface piping. The primary treatment processes to remove the contaminants from the groundwater will be air stripping with carbon adsorption polishing. Along with air stripping and carbon adsorption, solids removal (using bag filters will be employed to minimize clogging of the air stripper and carbon units. DNAPL removal (in the form of a settling tank) and hardness removal might be necessary to prevent clogging in the air stripper. The treated water will be discharged into surface water via a new discharge line to the Red Lion Creek. For the treatment of the air discharge from the stripper, vapor phase granular activated carbon units (equipped with a duct heater) will be utilized.

The process and associated treatment components indicated above are readily available and will appropriately meet the needs for this project. Therefore, detailed component design criteria for a treatment system will not be established. Rather, overall performance criteria will be developed. These criteria will be further evaluated and refined as part of pre-final design. The 60 percent design treatment system performance criteria are:

- An average 158 gpm flow from the extraction, conveyance, and discharge systems described above will be treated onsite to achieve the applicable discharge criteria listed above. Note that a safety factor of 30% was applied to this groundwater extraction rate when sizing pumps, process equipment, conveyance piping, and process piping.
- The treatment system influent contaminant concentrations are based upon data collected from selected onsite wells for which recent water quality data is available. While many of these wells lie outside of the immediate area of the proposed extraction well locations, when taken as a whole the data provides a good approximation of the groundwater quality underlying the SCD Site and adjacent properties. To ensure that the designed system is capable of treating extracted groundwater to the projected discharge limits, both average and maximum contaminant levels were used when sizing the proposed treatment system. To further ensure a conservative estimate, safety factors of 15% and 30% were applied to the average and maximum concentrations, respectively. These concentrations were then compared to the current facility NPDES limits, MCLs, DRBC Stream Quality Objectives, and DE Specific Water Quality Criteria to

identify which contaminants would most likely be regulated in the treatment plants discharge and what limits would be set for these contaminants. The average and maximum concentrations of the COCs used in the design criteria are shown in Table 4-1.

- Performance will be monitored and evaluated based on periodic sampling and analysis of surface water, monitoring wells and the treatment system influent/effluent streams. A monitoring and evaluation program to be implemented after system startup will include quarterly or semiannual sampling and analysis of the treatment system's influent and effluent. This sampling will be performed in addition to any sampling that may be required to meet the substantive requirements of the NPDES. Trend analyses will be performed on the compiled analytical data to track the remediation progress.
- Additional system specific design will be required by the successful subcontract bidder. During the bidding, bid evaluation, and pre-construction timeframes, the successful bidder will provide sufficient detail to demonstrate the adequacy of the proposed system design in meeting the project objectives.

4.6 Containment Barrier Wall

The containment barrier wall will be constructed to capture the contaminated groundwater plume underlying the SCD facility and prevent the plume's migration to the Red Lion Creek and its unnamed tributary. In the preliminary design phase the results of the SCD Site groundwater model were used to guide the proposed placement of the barrier wall. The extended wall alternative was used as the basis for placement, but the alignment of the proposed wall adjusted slightly to address constructability issues. Data from an upcoming geotechnical investigation will be used to refine the groundwater model and the barrier design. The updated model and alignment will be incorporated into the Intermediate Design Barrier Wall Addendum. To ensure that the barrier wall is effective, the following criteria were also used in its preliminary design:

- Dimensions – The barrier wall will be approximately 2,500 feet long. To ensure that groundwater flow is sufficiently impeded, the barrier wall will be approximately 2 to 4 feet thick. To minimize/eliminate the possibility of groundwater bypassing the barrier by flowing under it, the barrier will average approximately 35 feet in depth and will be keyed (to a depth of greater than 2 feet) into the clay layer separating the Potomac and Columbia formations.

Extraction wells will be placed near the ends of the barrier wall to minimize the potential of groundwater flowing around it.

- Barrier Life – Although the actual project life will be determined later in discussions with DNREC and EPA, the barrier is being designed at this time to have a minimum effective life of 30 years.
- Operations and Maintenance – The barrier is being designed for minimum O&M.
- Alignment – The barrier wall will be placed so as to prevent the flow of the site's contaminated groundwater to the Red Lion Creek and its unnamed tributary. To accomplish this, the barrier wall will extend along a line from just north of the Western Drainage Gully to the approximate northwest corner of the SCD property (adjacent to the Red Lion Creek wetlands). It will then proceed eastward along the edge of the Red Lion Creek wetlands to the northeastern corner of the SCD property. From that point, the wall will extend in a southward direction. The proposed alignment of the barrier wall is presented graphically on Drawing C-6 in Appendix G.
- Permeability – Testing of the proposed soil bentonite mixture will be required to ensure that an installed permeability of less than 1×10^{-7} cm/sec is achieved.
- Constructability – The barrier is being designed to allow the use of conventional construction means and methods. Although the ROD specifies that the barrier is to be constructed along the shoreline of the unnamed tributary and Red Lion Creek, the steep slopes present along the eastern edge of the unnamed tributary would make construction of the barrier difficult and could pose structural problems for a barrier of this type. Consequently, the intermediate design proposes to move the western leg of the barrier up the slope to more level ground. Additionally, the northern leg of the barrier has been moved up the slope away from the Red Lion Creek wetlands to minimize potential problems related to soft soils and high groundwater levels in that area. Unless prohibited by EPA or DNREC, trench spoils will be used as backfill for the barrier construction.

4.7 Treatment Buildings

The treatment system building at the site will be a pre-engineered building constructed of insulated steel on a concrete slab foundation. No windows will be installed on the buildings for security reasons. It is anticipated that the treatment building will be approximately 50 ft X 45 ft with an approximately 16 ft high ceiling to comfortably accommodate the expected treatment equipment and any possible hazardous materials required or hazardous waste generated in the treatment process. Heating and ventilation will be provided to maintain a minimum air temperature of 55 ^{o}F in the building.

Specific design criteria for the building components will be established later for civil/structural, mechanical, and electrical items. The building and all appurtenances will be required to conform to the BOCA 99 Code and the National Electrical Code, along with all local and state building codes.

4.8 Well Standards

Eight groundwater extraction wells (W-1 through W-8) for the extraction of contaminated groundwater will be constructed in accordance with appropriate DNREC requirements. The wells are designed for the extraction and treatment of captured contaminated groundwater from the bottom of the Columbia Aquifer. Based on the available historical data and the groundwater capture model that is included as Appendix A, pumping rates for each extraction well are estimated to be between 10 and 30 gpm. Based on the results of additional modeling that will be performed as part of this WA, pumping rates may be adjusted. However, pumping rates will ultimately be set based on yields that can be obtained during actual well construction/development during the RA implementation.

As described in Section 3.3.2, three product recovery wells (PRW-1 through PRW-3) will be installed at the SCD Site. Because of the nature of geology and the DNAPL contamination present at the SCD Site, these product recovery wells will be constructed with their bottoms located slightly below the top surface of the clay layer separating the Columbia and Potomac aquifers.

Seven additional monitoring wells (BMW-1 through BMW-7) will be installed on the downgradient side of the barrier wall. These and any other additional monitoring wells or piezometers that are subsequently determined to be necessary will be designed and constructed in accordance with the applicable DNREC standards. All wells will be designed and drawings sealed by a Licensed Geologist or Professional Engineer. Wells will be constructed by a Delaware certified well subcontractor under the supervision of a Licensed Geologist.

To address compatibility issues related to chlorinated benzenes and low pH groundwater, only chemically resistant materials such as FEP, PVDF, Teflon®, and stainless steel will be used in the construction of all wells and any associated pumps.

Well locations are presented graphically on Drawing C-1 in Appendix G.

4.9 Conveyance Systems

Piping will be required between the extraction wells and treatment system, the treatment system and discharge point, and for potable water from a point of connection to the treatment system. Piping designs will comply with local building codes. To minimize construction costs, an effort was made to utilize the minimum diameter piping that would still allow efficient operation of the system. Piping selection has also taken into account anticipated subsurface and loading conditions as discussed in Section 3.3.5. Stainless steel piping will be used for all contaminated groundwater conveyance. PVC will be used for transmission of treated water from the treatment system to the Red Lion Creek discharge point. Wrapped carbon steel will be used for potable water transmission lines. These materials were selected to ensure that structural integrity and pipe functionality are maintained throughout the project lifetime.

DNAPL from the product recovery wells will be pumped directly to collection vessels, which will be collected periodically and taken to a central short term storage area in the treatment system building. The DNAPL will subsequently be transported off-site for disposal at an appropriate RCRA-permitted facility. Only stainless steel piping will be used for product recovery piping applications.

4.10 Site Development, Land Acquisition and Easement Requirements

Based on the proposed limits of remedial activities at the SCD Site, it is expected that aside from the SCD property, only the Occidental Chemical properties to the east of the SCD Site will require easements. A summary of the property owners, property location/description of easement, and parcel number is provided in Table 4-2.

5.0 Basis of Design

5.1 Appropriate and Relevant or Applicable Requirements (ARARs)

The Remedial Action Contract Scope of Work under which this report has been prepared requires a detailed statement of how all applicable or relevant and appropriate regulations (ARARs) and federal and state public health and safety environmental requirements and standards will be met. This section provides summaries of the key ARARs and how the design will meet those requirements. A complete listing of all ARARs – as presented in the ROD – is included as Appendix F of this report. The ARARs also are an integral part of the Design Assumptions and Permitting described in Sections 5.2 and 5.6 below.

Section 121(d)(2)(A) of CERCLA incorporates into law the CERCLA Compliance Policy that specifies that Superfund remedial actions must meet any federal standards, requirements, criteria, or limitations that are determined to be legally ARARs. In addition, any promulgated state regulation, standard, criteria, or limitation that is more stringent than the corresponding federal regulation, standard, criteria, or limitation must be adhered to during the remedial action for the SCD Site. The federal statutes that are applicable to the SCD Site include the following:

- Clean Air Act (CAA),
- Clean Water Act (CWA),
- Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments (HSWA),
- Protection of Floodplains,
- Protection of Wetlands,
- Coastal Zone Management Act and Coastal Zone Act Reauthorization Amendments,
- Archaeological and Historical Preservation Act of 1974, and
- Safe Drinking Water Act (SDWA).

Applicable state statues for the SCD Site include the following:

- Delaware Regulations Governing the Control of Water Pollution,
- Delaware Water Quality Standards,

- Delaware Regulations Governing the Construction of Water Wells,
- Delaware Regulations Governing the Allocation of Water,
- Delaware Regulations Governing Public Drinking Water Systems,
- Delaware Ambient Air Quality Standards,
- Delaware Coastal Zone Act,
- Delaware Wetlands Regulations,
- Delaware Regulations Governing the Use of Subaqueous Lands,
- Delaware Regulations Governing the Control of Air Pollution,
- Delaware Regulations Governing Solid Waste,
- Delaware Regulations Governing Hazardous Substance Cleanup,
- Delaware Sediment and Stormwater Management Regulations Ambient Air Quality Standards, and
- Delaware Regulations Governing Hazardous Waste (DRGHW).

ARARs can be chemical specific, location specific, or action specific. ARARs for the SCD Site were reviewed and updated as part of the ROD and RD process and are considered during the RD. The following sections present summaries (taken in part from the ROD) of the federal and state ARARs that apply to the SCD Site for the RD.

5.1.1 Chemical-specific ARARs

Chemical specific ARARs are usually health or risk based numerical values limiting the amount or concentration of a chemical that may be found in, or discharged to, the environment. Chemical specific ARARs mandate that contamination levels found in site groundwater meet certain criteria to protect human health and the environment. Chemicals of concern at the site include chlorinated benzene compounds, benzene, toluene, and nitrobenzene. All of the ARARs provide some specific guidance on "acceptable" or "permissible" concentrations of contaminants in water. The following are the chemical-specific ARARs that apply to the SCD Site and have been considered as part of this design:

The Clean Water Act sets water quality criteria at levels protective of human health and of aquatic life in streams, lakes, and rivers. The CWA criteria will be considered relevant and appropriate for this site and will be considered in determining the effectiveness of the Remedial Action.

The Clean Air Act passed in 1977 governs air emissions resulting from remedial actions at CERCLA sites. National Ambient Air Quality Standards (40 CFR Part 50) have been promulgated under the CAA for six criteria pollutants, including airborne particulates. No specific air quality standards for the contaminants of concern at the site have been promulgated. The associated Delaware Implementation Plans for the Attainment and Maintenance of National Ambient Air Quality Standards (40 CFR Section 52 420-460 Subpart I) codify Delaware's Implementation Plan for attaining these standards. To the extent that remedial actions undertaken at the site emit and regulate air contaminants, the CAA would be relevant.

The National Emissions Standards for Hazardous Air Pollutants (40 CFR part 61) promulgate standards for air emissions from specific sources. These standards will be considered relevant and appropriate for the emissions from the air stripper.

Similarly, the Delaware Ambient Air Quality Standards, which establish ambient air standards at the state level, are applicable to emissions from the air stripper included as part of this design. These standards will be considered in developing the criteria for the treatment of off-gas from the air stripper.

5.1.2 Location-specific ARARs

Location specific ARARs include restrictions on certain types of activities based onsite characteristics. Location-specific ARARs govern activities in critical environments such as wetlands, endangered or protected species habitats, and historic locations.

The Coastal Zone Management Act (16 USC Section 1451) and the Coastal Zone Act Reauthorization Amendments of 1990 require that any activities that directly affect the coastal zone and are conducted or supported by federal agencies be conducted in a manner that is consistent with the approved state coastal zone management program. Because the SCD Site is located in the Delaware coastal zone, both the Act and the related Amendments are applicable to the site. All Remedial Action activities will be performed – to the extent practicable – in a manner consistent with Delaware's coastal zone management program, and DNREC will be notified of EPA's determination that the activities are consistent to the extent practicable.

The Archaeological and Historical Preservation Act of 1974 (16 USC Section 469) outlines requirements to guard against the loss of significant scientific, historical, or archaeological data. This Act is considered applicable to the site and will therefore require that an effort be made to identify any potential resources that might be put at risk by the construction activities related to the Interim Groundwater Remedy. If any such resources are identified, steps will be taken to minimize the potential for any adverse impact.

The Protection of Floodplains (40 CFR Part 6, App. A) regulations codify the EPA policies for carrying out Executive Order 11988. These regulations require that activities within the 100 year floodplain be conducted in a manner that avoids adverse effects, minimizes potential harm, and restores and preserves the beneficial values of these areas.

Because a portion of the construction activities will take place in the 100 year floodplain, these regulations are applicable to this RD.

The Protection of Wetlands (40 CFR Part 6, App. A) regulations codify the EPA policies for carrying out Executive Order 11990. These regulations require that activities within wetlands be conducted in a manner that avoids adverse effects, minimizes potential harm, and restores and preserves the beneficial values of these areas.

Although the construction activities are not expected to infringe upon the wetlands, the containment system will affect the natural groundwater flow and the treatment system will discharge to the Red Lion Creek. This indicates that the Interim Remedial Action will alter the hydrology of the wetlands surrounding the Red Lion Creek and its unnamed tributary. For this reason, these regulations are applicable to this RD.

The Delaware Coastal Zone Act (7 Delaware Code Sections 7003-7004) controls the location, type, and extent of industrial activities in Delaware's coastal areas. These regulations are considered relevant and appropriate for the activities at the SCD Site. As discussed in Section 3.3.3, a review of these regulations revealed that the use of a thermal oxidizer or catalytic oxidizer to treat the off-gas from the air stripper included in this RD would likely be prohibited at the SCD Site. Consequently, an alternative treatment technology was chosen. Additional discussions are being conducted with the Delaware Coastal Zone Industrial Control Board to determine if a thermal oxidizer used solely for pollution control might be exempted from the incinerator/oxidizer prohibition.

The Delaware Wetlands Regulations require that activities that adversely affect wetlands be permitted and that such permits be approved by the county or municipality having jurisdiction over the location of the work. These regulations are applicable to the Interim Groundwater Remedy because of the aforementioned effects that the containment barrier will have on the wetlands hydrology. As stated in Table 10 of the ROD, because the RA activities will be completed onsite, no permit will be required in accordance with Section

121 of CERCLA. However, all substantive requirements of the regulations will be met. Because eight years have passed since the ROD was published, it might be advisable for the EPA to revisit this determination. In the event that it is subsequently decided that permits are required for these activities, BVSPC will complete the appropriate permit application process.

The Delaware Regulations Governing the Use of Subaqueous Lands require that activities that affect public or private subaqueous lands be permitted. These regulations are applicable to the Interim Groundwater Remedy because of the aforementioned effects that the containment barrier will have on the wetlands hydrology. As stated in Table 10 of the ROD, because the RA activities will be completed onsite, no permit will be required in accordance with Section 121 of CERCLA. However, all substantive requirements of the regulations will be met. In the event that it is subsequently decided that permits are required for these activities, BVSPC will complete the appropriate permit application process.

5.1.3 Action-specific ARARs

Action specific ARARs are usually technology or activity based directions or limitations that control actions taken at hazardous waste sites. Action specific ARARs are triggered by the types of actions under consideration. The following are the action-specific ARARs that apply to the SCD Site:

The Clean Water Act and National Pollution Discharge Elimination System (NPDES) Requirements (40 CFR Sections 122.2, 122.4, 122.5, 122.21, 122.26, 122.29, 122.41, 122.43-45, and 122.47-48) regulate the discharge of pollutants into navigable waters of the U.S. Because the groundwater treatment system will discharge treated groundwater into the Red Lion Creek the CWA and NPDES requirements are applicable to the SCD Site. The treated water will meet the limits set by DNREC and the EPA for a new outfall on the Red Lion Creek. Wastewater generated during decontamination activities performed as part of site construction activities shall be properly managed in accordance with DRGHW regulations and/or the CWA.

Although Table 10 of the ROD specifically states that no NPDES permit is required for a discharge from a new treatment system such as the one proposed here, the fact that eight years have elapsed since the ROD was published suggests that it might be advisable for EPA to revisit this determination. In the event a NPDES permit is required, BVSPC will complete the application process, and final discharge limits will be based on those listed in the NPDES permit.

The Delaware Regulations Governing the Control of Water Pollution govern point and non-point source discharges to Delaware waters. The rules include requirements for permits, permit applications, permit conditions, and monitoring. The rules are applicable for remedial actions involving a discharge to surface water (such as the proposed groundwater treatment system) as well as for stormwater runoff into the Red Lion Creek and its unnamed tributary.

Although Table 10 of the ROD specifically states that no NPDES permit is to be obtained for a discharge from a new treatment system such as the one proposed here, in the event a NPDES permit is required, BVSPC will complete the application process, and final discharge limits will be based on those listed in the NPDES permit.

The Delaware Regulations Governing the Construction of Water Wells establish requirements for the construction, location, repair, use, and abandonment of wells and pumping equipment. Construction of all new monitoring and extraction wells, and the abandonment of any existing wells will be performed in accordance with these regulations.

The Delaware Regulations Governing the Allocation of Water cover the permitting of proposed groundwater extraction/recovery systems. These regulations are applicable to the extraction wells included in this project.

Table 10 of the ROD specifically states that no permit is required for the proposed groundwater extraction system, but the substantive requirements of these regulations will be met.

The Delaware Water Quality Standards set forth water quality standards for waters of the State. The standards are based upon water uses that are to be protected and are considered by DNREC in its regulation of discharges to surface waters. These would be applicable to point or non-point discharges from the site or recovered groundwater treatment discharges to the surface water.

The water quality standards are considered relevant to the site and will be complied with as part of meeting the substantive requirements of the NPDES permit process for treatment systems discharges.

The Delaware Stormwater and Sediment Regulations establish a statewide stormwater and sediment management plan. The requirements of these regulations are applicable to the Interim Groundwater Remedy because it is anticipated that over 5,000 square feet of land will be disturbed (e.g., clearing, grading, excavation, etc.) during site preparation and construction activities. To ensure compliance with this program, a site wide stormwater and sediment management plan will be put in place prior to the start of construction related to the Interim Groundwater Remedy.

A Memorandum of Agreement between DRBC and EPA III (October 23, 1991) establishes standards for discharges to surface water and withdrawals from aquifers in the Delaware River Basin. Under this MOA, the DRBC does not review or require permits for groundwater withdrawal or recharge for federal Superfund sites in EPA Region III. However, the MOA does require that groundwater withdrawal meet the following four ARARs taken from the DRBC Groundwater Protected Area Regulations:

- Extraction wells must have readily accessible capped ports and drop pipes so that water levels may be measured under all conditions.
- Extraction wells shall be metered with an automatic continuous recording device that measures flow within 5% of actual flow. A daily record shall be maintained and annual withdrawal totals shall be reported to DRBC.
- Extraction wells shall not significantly interfere with domestic or other existing wells.
- The operation of extraction wells shall not cause long-term progressive lowering of groundwater levels, permanent loss of storage capacity or substantial impact on low flows of perennial streams. The MOA establishes standards for discharges to surface water and withdrawals from aquifers in the Basin.

Resource Conservation and Recovery Act (RCRA), as amended RCRA 42 USC §§6901 et seq, deals with the treatment and disposal methods of all hazardous wastes. Because DNAPL wastes and – at least initially – the extracted groundwater recovered from the site are expected to be hazardous and will be treated as hazardous wastes. In addition, it is possible that the spent carbon from the liquid-phase and vapor-phase carbon adsorption vessels will also be considered hazardous. For these reasons RCRA and the associated regulations under the DRGHW will be considered applicable to the SCD Site. Consequently, all hazardous wastes will be handled in accordance with the Federal hazardous waste regulations (40CFR §§261, 262.10-.58, 263, 264.170-.178, 264.1030-.1037, 268, and 270) promulgated under RCRA and/or the corresponding regulations under the DRGHW. Representative samples of spent carbon will be analyzed to determine whether the spent carbon will need to be treated as a hazardous waste. Until such a determination is made, the spent carbon will be handled as hazardous waste.

The Delaware Regulations Governing Solid Waste establish regulations for the development of a solid waste management program. Solid waste generated as part of the construction and operation of the Interim Groundwater Remedy will be handled in accordance with these regulations.

The Occupational Health and Safety Act (OSHA) (29 CFR Parts 1904, 1910, and 1926) provides occupational safety and health requirements applicable to workers engaged in onsite field activities. The regulations are applicable to onsite work performed during implementation of remedial actions. A Site Health and Safety Plan (HASP) has been written for all RD field activities at the SCD Site in accordance with OSHA occupational and health requirements. A separate HASP for Remedial Action activities will be prepared for construction phase services.

The Delaware Regulations Governing the Control of Air Pollution describe permitting requirements for air strippers that emit more than 2.5 pounds per day of pollutants. Because it is anticipated that emissions from the treatment system's air stripper will be greater than this level, these regulations are applicable to the Interim Groundwater Remedy. Consequently, the substantive requirements of these regulations will be met. The selected remedy will be designed so that any air emissions from the treatment process will be in accordance with these regulations.

5.1.4 ARARs To Be Considered

The following are ARARs have been considered for the SCD Site:

The Safe Drinking Water Act (SDWA) promulgated National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs) (40 CFR Part 141). MCLs are enforceable standards for contaminants in public drinking water supply systems. They consider not only health factors, but also the economic and technical feasibility of removing a contaminant from a water supply system. The EPA has also proposed Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are non-enforceable guidelines that do not consider the technical feasibility of contaminant removal. Secondary MCLs (40 CFR Part 143) are intended as guidelines to protect the public welfare. Contaminants covered are those that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearances, and those that may limit public acceptance of drinking water provided by public water systems. The state of Delaware has adopted the MCLs under Section 22.60 of the Delaware Regulations Governing Public Drinking Water Systems.

The proposed treatment system design will not discharge treated groundwater to any public drinking water supply source. Although the Columbia Aquifer from which the contaminated groundwater is being withdrawn is not currently being used as a public drinking water supply in the immediate area surrounding the SCD Site, it is classified as a Class II B aquifer (under the Groundwater Protection Strategy of 1984) because of its potential to be used as a drinking water source. In addition, it is apparent that at least one private well is screened in the Columbia Aquifer within one mile of the SCD Site. Although the ROD does not specify cleanup levels for the groundwater, the MCLs for the contaminants of concern at the site might be used in the determination of future cleanup levels. Consequently, the MCLs could possibly be considered relevant and appropriate in the future.

The Delaware Comprehensive Water Resources Management Committee Reports will be considered in developing the groundwater monitoring strategy for evaluating the effectiveness of the Interim Groundwater Remedy.

Because the ROD does not specify cleanup limits for the Interim Groundwater Remedy, neither the Health Effects Assessment nor the EPA Health Advisories – which deal with risk based criteria and the setting of cleanup standards for the protection of human life – will not be considered at this time.

OSWER Directive #9355.0-28, Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites. Air emissions from this Superfund Site shall be controlled through the use of carbon adsorption.

The Delaware Executive Order 56 on Freshwater Wetlands and the Governor's Roundtable Report on Freshwater Wetlands will be considered because of anticipated changes in wetlands hydrology that will result from implementation of the Interim Groundwater Remedy. No construction activities are expected to extend onto the wetlands surrounding the Red Lion Creek and its unnamed tributary.

5.2 Design Assumptions

During preparation of this design, assumptions have been made regarding the sequence of work; work by others; property access; treatment system performance; and available information at each location of interest. A description of each of the relevant assumptions is presented below, including (where applicable) a justification or supporting documentation regarding why BVSPC believes the assumption is accurate and acceptable.

- USEPA will obtain any necessary access agreements for constructing the extraction wells, containment barrier wall, and accessing the discharge piping/point from individual property owners in the general locations shown on the drawings in Section 7.
- The estimated influent parameters described in Section 4.5 are assumed to be typical of the groundwater that will be encountered for the extraction well to be constructed during the RA. Because plant operations have ceased, it is not expected that additional sources of site-related contaminants will be introduced into the groundwater. Also, historical data has shown little change in the extent of the groundwater contaminant plume since the RI was performed.
- Assumed extraction rates can be obtained. This assumes that suitable water bearing features will be encountered during extraction well construction. If extraction rates cannot be achieved, construction of additional extraction wells might be required. Groundwater levels have been fairly well mapped across the potential extraction area. In addition, data from recovery wells operated at the SCD Site and on nearby properties indicate that the assumed extraction rates can be achieved.
- Cost-effective water treatment technologies that are capable of achieving the reductions in site-related contaminants necessary to meet NPDES permit limits are readily available.
- Cost-effective off-gas treatment technologies that are capable of achieving the reductions in site-related contaminants necessary to meet any State-imposed air emissions permit limits are readily available.
- The clay layer separating the Columbia and Upper Potomac aquifers acts to prevent or substantially limit any hydraulic connection between the aquifers across the SCD Site. Based on the preliminary results of a recent sampling event, it is possible that site-related contamination might have crossed from the

Columbia into the Potomac Aquifer. If the presence of this contamination is confirmed in the validation process and upcoming confirmation sampling effort, this assumption might have to be reevaluated.

- The clay layer separating the Columbia and Upper Potomac aquifers is thick enough in the proposed containment barrier wall construction area to allow successful keying of the barrier wall into it.
- Construction is scheduled to commence in Fall 2004.

5.3 Process Flow Diagrams

The process flow diagrams provide a schematic of the treatment system that is anticipated for all locations of interest. As the design is developed further, some modifications may be made to the general process flow diagram and piping and instrumentation diagrams included with the Intermediate Design Drawings in Section 7.

5.4 Operation and Maintenance Provisions

Minimum requirements for O&M activities and reporting by the RA subcontractor will be further developed during the Pre-Final phase of this design and any changes will be incorporated into the RA Plans and Specifications. The RA subcontractor will be required to submit for approval an O&M Plan providing a schedule and description of activities to monitor and maintain the integrity of the remedial activities.

The plan will include system inspection and repair, routine maintenance of mechanical equipment, site inspection and security, erosion and sedimentation control, and site vegetation. Additionally, a Health and Safety Plan (HASP) will be developed for all O&M activities.

5.5 Permitting

Although the ROD states that various permits will not be required for this Remedial Action, the design assumes that the permits shown in Table 5-1 may be required to install, start up, and operate the Interim Groundwater Remedy.

6.0 Project Delivery Strategy

In the approved Remedial Design Work Plan dated September 13, 2002, a sub-task was included to determine the subcontracts, subcontracting procedures, and milestone schedule of required subcontracts to be prepared in the RD for implementation in the RA.

Developing a subcontracting strategy for a remedial construction project typically considers the structure of the project, how the various aspects of the project are related, whether any portion of the project requires capabilities unique to one type of contractor, the projected schedules of each component, and the potential impact that each component will have on the others. Currently the soil/sediment remedy and the interim groundwater remedy for the SCD Site are part of the same operable unit. In addition, the interim groundwater remedy includes two major aspects (i.e., barrier wall and groundwater extraction/treatment system) that typically require very different construction skill sets. Consequently, there are a number of variables that will impact any decision on contracting strategy for the construction portion of this project.

The soil/sediment remedy – if implemented as currently specified in the ROD and envisioned in the Soil/Sediment Design Comparison Study (BVSPC, 2003) – would require the installation of containment feature around (and excavation of) the contaminated areas of the tributary wetlands. Because there is considerable overlap between the skills needed to accomplish these activities and those needed to construct the barrier wall portion of the groundwater remedy, it would likely be more cost-effective to combine these two activities under one construction subcontract. Additionally, combining these activities under a single subcontract would ease the coordination of two substantial construction activities occurring in close proximity. Further supporting this approach is the potential to use the western arm of the groundwater containment barrier wall as the eastern wall of the wetlands containment feature. However, because of higher than anticipated projected costs for the excavation and treatment of the contaminated wetlands materials, EPA is currently investigating the potential for using another, less intrusive, method (in-situ chemical oxidation) of treating the wetlands materials. If this alternative approach is selected, then combining the soil/sediment remedial work and the containment barrier construction under one subcontract would not hold the same benefits.

In a similar regard, while combining the construction of the barrier wall with the construction of the groundwater extraction/treatment system would ease coordination of activities, the skills required for each of the two activities do not have substantial overlap. Consequently, if a single subcontract is executed to cover both activities, it is likely that the selected subcontractor would employ a second tier subcontractor to complete the portion of the construction that does not fall within their specialty. This could result in increased costs (in the form of pass-through charges) in some areas of the project.

Start up and initial operation and maintenance options will be included in each construction subcontract. Subsequent operation and maintenance activities will be further evaluated with EPA. Start up testing requirements will focus on permit compliance, obtaining extraction rates to contain the contaminated plume and maintaining site groundwater levels at preconstruction elevations. The schedule for preparation of the subcontract will follow the schedule included in the approved WA and any subsequent modifications. An updated RA Construction Schedule is included in Section 9.

Permit compliance for the site will be determined in discussions with EPA, DNREC, and DRBC officials. The Interim Groundwater Remedy – as proposed – will meet the substantive requirements of all ARARs. Initial estimates of the required compliance activities are based on the SCD facility's most recent NPDES and air emissions permits. Included in the expected compliance requirements will be regular sampling of the treatment system's air emissions and treated water discharge as well as sampling of the system's influent and intermediate (i.e., within the treatment train) water quality. Because of the anticipated reduction in groundwater flow to the wetlands surrounding the Red Lion Creek and its unnamed tributary, additional monitoring of downgradient groundwater levels and wetlands conditions might also be required. The subcontract being prepared under this WA, WA No. 038-RDRD-03H6, will include start-up compliance requirements.

Containment of the contaminant plume is to be achieved by construction of the containment barrier wall and pumping from eight wells located to the north of the SCD facility fence line. Measurement of containment is anticipated to be a long term, ongoing effort. Long term measurement of plume containment will be used to adjust pumping rates or add more extraction wells. The long term containment objectives would be considered but not be incorporated as a subcontractor requirement in the initial start up and operations and maintenance of the systems under this WA.

Similarly, long term monitoring of contamination would be part of the overall containment objectives for the site. Discharge compliance sampling and groundwater contaminant monitoring sampling will be conducted by BVSPC with the assistance of the Subcontractor. Typically this would indicate that sample analyses would be performed by an EPA CLP laboratory, but the need for short turnaround times might necessitate the use of a local non-CLP lab for certain analyses. A final decision on laboratory services will be made following future discussions with EPA and DNREC. Thus, the need for CLP or subcontracted laboratories, as well as the need for other long term service subcontracts are yet to be determined under WA No. 038-RDRD-03H6. Some of these requirements would be beyond the scope of the initial remedial action subcontract, but will be further identified as the design progresses under this WA. Telephone, electrical and water services will be arranged through local utility providers and paid on a monthly or quarterly basis as per utility requirements.

For the remedial construction subcontract, both performance based specifications and means and methods specifications are anticipated. A performance specification is anticipated for the extraction and treatment process as a feature of the project delivery strategy. Indications from the environmental services industry are that several available treatment systems can achieve the groundwater contamination reduction anticipated to be required under the NPDES in conjunction with the pumping rates needed to meet the ROD objectives. To ensure a competitive bidding situation with lower costs to the government, extraction and treatment performance specifications, rather than prescriptive specifications will be developed to allow bidding, construction, and operation of various treatment systems.

Performance specifications require three elements: requirement, criterion, and test. The requirements are qualitative statements of desired performance. The criterion is a quantitative statement of desired performance. The test is an evaluative procedure to ensure compliance with the criteria. Performance specifications are used to describe attributes of a system such as serviceability, durability, safety, and the environment. Thus, the design development will focus on these attributes and elements for pumping and treatment in the specifications.

A fixed price with unit price adjustment subcontract will be prepared for the initial construction. Follow-on start up and operations & maintenance under the contract may be fixed price, cost reimbursable, or time and materials. This portion of the work requires further development. Either two-step bidding or a negotiated procurement is expected for the construction. Performance and payment bonding will be required for the subcontract.

Measurement and payment items will be structured to allow flexibility in adjusting the constructed remedial system as a component of the project delivery schedule. The final design will establish the performance of the treatment system and the number, location, and materials for the wells, conveyance systems, and other features of the remediation. During construction and testing, the number of wells, well sizes, locations, etc. may require adjustment for optimal remediation performance. Fixed unit adjustment prices can be incorporated into the Final Contract Documents to allow adjustments by the remediation subcontractor with the approval or at the direction of BVSPC and EPA Region III.

The project delivery strategy will be in accordance with the Prime Contract, the Prime Contract Small Business Utilization Goals, and the appropriate FAR clauses. A feature of the project delivery strategy is to prepare the Final Contract Documents for subsequent bidding and award to a Small Business Enterprises (SBE). This will be accomplished by either pre-qualifying only SBE firms as potential subcontractors, or by giving preference to SBE firms in their bid evaluation. Because of the anticipated cost of the subcontract, the subcontract will be bid to, or a preferential evaluation system will be developed for, SBEs. There are multiple small business firms that are capable of performing the anticipated work and small business utilization is a prime contract goal and overall agency goal of EPA. Preference may be given in a 10% price differential or a weighted evaluation process that assigns higher points to SBE as part of an overall evaluation process.

The ROD for the site refers to a long-term groundwater monitoring program being in compliance with an EPA approved O&M Plan. Such a plan would be for the overall site and might include provisions for the O&M of the Final Soil/Sediment Remedy as well as this Interim Groundwater Remedy. The responsibility for preparation of the overall site O&M Plan is to be determined. However, this WA assumes that BVSPC (or its subcontractor) will prepare an initial O&M Manual for the equipment and facilities installed under the RA subcontract.

In preparing the O&M Manual specifications, consideration will be given to structuring options within the Final Contract Documents to allow the RA contractor limited or extended O&M of the system after start up and shake down. As the design develops for the RA, BVSPC will consider the most cost effective method of completing the O&M for the government. A final recommendation on O&M alternative contracting methods will be included in the revised project delivery strategy to be submitted with the Final Contract Documents after further discussions with EPA. Such alternatives would be expected to be consistent with requirements outlined in the U.S. Environmental Protection Agency (EPA) document *Consideration for Preparation of Operation and Maintenance Manuals* (EPA 430/9-74-001).

7.0 Intermediate Design Drawings

Intermediate Design Drawings are included in Appendix G. Sheet reference number GG-1, Site Location Plan & Drawing Index, includes the listing of sheets anticipated for the Pre-Final and Final Design. Additional sheets will be developed and submitted as part of the Intermediate Design Containment Barrier Addendum. As part of this Intermediate Design submission, the following sheets have been developed in accordance with the work plan:

- GG-0 Cover Sheet
- GG-1 Site Location Plan & Drawing Index
- GG-2 Legend, Abbreviations, and General Notes
- GP-1 Instrumentation Legend, Abbreviations
- GP-2 Generalized Treatment System Process Flow Diagram
- GP-3 through GP-5 Piping and Instrumentation Diagrams
- C-1 Site Layout Plan with Erosion and Sediment Controls
- C-2 Conveyance and Discharge Piping Runs
- C-3 Miscellaneous Detail Drawings
- C-4 Well Details
- C-5 Product Recovery Well Details
- C-6 Site Layout Plan (Groundwater Barrier Wall Plan View)
- C-7 Groundwater Barrier Section View
- AS-1 Architectural and Structural Building Plan
- ME-1 General Treatment Plant Layout

8.0 Preliminary Specifications

The technical specifications that are anticipated to be used for Remedial Design Plans and Specifications are listed below and included as Appendix H. Note that certain barrier related specifications (shaded in the following list) among the following will be completed and submitted as part of the Intermediate Design Containment Barrier Addendum.

DIVISION 1 - GENERAL REQUIREMENTS

Section 01015	Project Requirements
Section 01025	Measurement and Payment
Section 01070	Abbreviations
Section 01300	Submittals
Section 01400	Quality Control
Section 01500	Temporary Facilities
Section 01605	Sampling for Chemical Testing
Section 01606	Materials Handling and Disposal
Section 01610	General Equipment Stipulations

DIVISION 2 – SITEWORK

Section 02050	Demolition and Salvage
Section 02150	Wells
Section 02200	Earthwork
Section 02202	Trenching and Backfilling
Section 02223	On-Site Storage, Fill, and Stabilization of Excavated Material
Section 02225	Interim Cap Over Barrier
Section 02270	Erosion & Sediment Control
Section 02395	Soil-Bentonite Barrier
Section 02396	Laboratory Testing of S-B Backfill
Section 02512	Asphalt Concrete Paving
Section 02600	Existing Utilities
Section 02630	Polyvinyl Chloride (PVC) Pressure Pipe
Section 02704	Pipeline Pressure and Leakage Testing
Section 02930	Seeding and Sodding
Section 02950	Trees, Shrubs and Ground Cover

DIVISION 3 - CONCRETE

Section 03301	Cast-in-Place Concrete
Section 03411	Precast Concrete

Section 03600 Grout

DIVISION 4 – MASONRY (Not used)

DIVISION 5 – METALS (Not used)

DIVISION 6 – WOOD AND PLASTIC (Not used)

DIVISION 7 – THERMAL AND MOISTURE PROTECTION (Not used)

DIVISION 8 – DOORS AND WINDOWS (Not used)

DIVISION 9 – FINISHES (Not used)

DIVISION 10 – SPECIALTIES (Not used)

DIVISION 11 – EQUIPMENT
Section 11180 Sump Pumps
Section 11210 Submersible Well Pumps
Section 11211 Centrifugal Pumps
Section 11430 Groundwater Treatment System- Performance Specifications
Section 11710 System Monitoring and Cleanup Verification

DIVISION 12 – FURNISHINGS (Not used)

DIVISION 13 - SPECIAL CONSTRUCTION
Section 13120 Pre-Engineered Structure

DIVISION 14 – CONVEYING SYSTEMS (Not used)

DIVISION 15 – MECHANICAL
Section 15060 Miscellaneous Piping
Section 15100 Miscellaneous Valves
Section 15140 Pipe Supports
Section 15400 Plumbing
Section 15500 Heating and Ventilating

DIVISION 16 – ELECTRICAL
Section 16050 Electrical
Section 16670 Lightning Protection System
Section 16721 Fire Detection and Alarm
Section 16901 Control System

9.0 Preliminary Remedial Action Schedule

An updated RA construction schedule is presented in Appendix I. The entire duration of the remedial action is approximately 41 months, which includes bidding, an approximate nine-month construction duration, an additional three-month startup, testing and prove out period, and two years of initial O&M. The schedule is based on the RA Request for Proposal (RFP) being issued on June 29, 2004.

The schedule assumes that the subcontractor(s) will construct the treatment system prior to the start of the barrier wall construction. To minimize the potential impacts of winter weather on the structural integrity of the containment barrier and related project costs, the schedule also assumes that the construction of the containment barrier wall will be postponed until the end of March 2005. This assumption will be further evaluated as the design progresses. Therefore, the construction period may be adjusted to allow for revised construction approach.

10.0 Intermediate Cost Estimate

An updated RA construction cost estimate was prepared using M-CACES for Windows Release 1.2C. This estimate includes all capital costs required for construction of the Interim Groundwater Remedy as well as operations and maintenance costs for two years. Copies of the M-CACES Summary Pages are provided in Appendix J. The detail pages contain further breakdown levels but have not been included in this report. Table 10-1 further summarizes the M-CACES estimates in terms of construction and O&M.

Table 10-1
Preliminary Cost Estimate

Construction Cost-Subtotal	$ 2,220,100
Operation & Maintenance-Subtotal	$ 1,938,350
TOTAL REMEDIATION	$ 4,158,450

11.0 References

BVSPC, 2003. *Soil/Sediment Design Comparison (15%) Study, Standard Chlorine of Delaware Site, New Castle County, Delaware.* Black & Veatch Special Projects Corporation. June 2003.

CRA, 2001. *Supplemental Remedial Design Investigation and Intermediate Design Report for Interim Groundwater Remediation Program. Standard Chlorine of Delaware Site. EPA Order No. III-96-73-DC.* Conestoga-Rovers & Associates. September 2001.

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DNREC, 2003. *Comments on Preliminary Groundwater Basis of Design/Design Criteria Report, Standard Chlorine of Delaware Site, New Castle Delaware, USEPA Work Assignment No. Black & Veatch Project No. 47118.0128.* Delaware Department of Natural Resources and Environmental Control (DNREC). August 2003.

EPA. Consideration for Preparation of Operation and Maintenance Manuals (EPA 430/9-74-001).

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ROD, 1995. *Superfund Program Record of Decision, Standard Chlorine of Delaware Superfund Site, New Castle, Delaware.* EPA, March 9, 1995.

WESTON. 1992. *Remedial Investigation (RI) Report, Standard Chlorine of Delaware Inc. Site, Delaware City Delaware.* Roy F. Weston, Inc., September 1992.

WESTON. 1993. *Feasibility Study (FS) Report, Standard Chlorine of Delaware Inc. Site, Delaware City Delaware.* Roy F. Weston, Inc., May 1993.